

TWR- 50170

RSRM FORWARD DOME INHIBITOR REGION IMPROVEMENT  
FINAL REPORT

DECEMBER 1989

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GEORGE C. MARSHALL SPACE FLIGHT CENTER  
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812**

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***Thiokol* CORPORATION**  
***SPACE OPERATIONS***

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**RSRM FORWARD DOME INHIBITOR REGION IMPROVEMENT**

**FINAL REPORT**

DECEMBER 1989

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**CONTENTS**

|                                    | <u>Page</u> |
|------------------------------------|-------------|
| 1.0 INTRODUCTION AND SUMMARY ..... | 1           |
| 2.0 CONCLUSIONS .....              | 3           |
| 3.0 RECOMMENDATIONS .....          | 4           |
| 4.0 DISCUSSION .....               | 4           |
| 4.1 General .....                  | 4           |
| 4.2 Individual Tests .....         | 5           |
| Test Dome No. 1 (PSA-1) .....      | 5           |
| Test Dome No. 2 (PSA-2) .....      | 6           |
| Test Dome No. 3 (PSA-3) .....      | 7           |
| Test Dome No. 4 (PSA-4) .....      | 8           |

**FIGURES**

|   |    |
|---|----|
| 1. Three-Piece Patterning/Breather Cloth Patterns .....     | 10 |
| 2. Insulation Layup Changes .....                           | 11 |
| 3. Typical Forward Segment, Insulation Cure Cycle .....     | 12 |
| 4. PSA-1 Thickness and Average Circumferential Profiles ... | 13 |
| 5. PSA-2 Thickness and Average Circumferential Profiles ... | 14 |
| 6. PSA-3 Thickness and Average Circumferential Profiles ... | 15 |
| 7. PSA-4 Thickness and Average Circumferential Profiles ... | 16 |

**ATTACHMENTS**

|   |    |
|---|----|
| I. PSA-1 Defect Location (Mapping) Chart .....  | 17 |
| II. PSA-2 Defect Location (Mapping) Chart ..... | 21 |
| III. PSA-1 Thickness Measurements.....          | 23 |
| IV. PSA-2 Thickness Measurements .....          | 25 |
| V. PSA-3 Thickness Measurements .....           | 27 |
| VI. PSA-4 Thickness Measurements .....          | 29 |
| DISTRIBUTION .....                              | 31 |

**Process Engineering Technical Report Categories**

|                        |               |            |
|------------------------|---------------|------------|
| Forward Segment        | Rubber, NBR   | Insulation |
| Bond and Void Problems | Void          |            |
| Delaminations          | Vulcanization |            |

## 1.0 INTRODUCTION AND SUMMARY

As a result of the RSRM 10A forward segment discrepant areas of large voids, folds, and unbonds in the forward dome inhibitor region and subsequently similar defects detected in the same region from the post-fired RSRM 5A and 5B flight domes and TEM 2 and TEM 4 forward domes, full-scale process simulation testing was conducted. This testing was documented and controlled by Test Plan WTP-0200. This testing was initiated to duplicate the current process to determine the defect causes and to conduct the required testing of proposed process modifications and changes that would achieve uniform, controlled insulation thickness and minimize voids and wrinkles in the forward dome inhibitor region. It is concluded that the causes of insulation inhibitor region discrepancies were:

1. Excessive rubber under the igniter mold ring
2. The pressure transfer ring
3. The 5U rubber layup requirements of specific joints
4. The current fan-type patterning, breather cloth, and Chickopee breather strip installation method.

It is recommended that 1) the process modifications in insulation layup (patterning, breather, and Chickopee cloths) be incorporated, 2) the pressure transfer ring be eliminated, and 3) requirements be established to control the entire vacuum bagging operation of forward domes to ensure it is accomplished correctly.

Four test domes were laid up, cured, and evaluated in this study. These are briefly described as follows:

**Test No. 1** - This test simulated the current methods and procedures used during the insulation processing of flight forward segments. This test was successful in demonstrating all of the discrepancies observed during evaluation of the forward dome inhibitor regions.

**Test No. 2** - This test was the first attempt to eliminate the discrepancies noted in this report. The modifications to the normal processes were the addition of two 0.100-in. thick calendared plies over the OD extrusion for 180 degrees, the change to a three-piece circumferential patterning cloth and breather cloth system (Figure 1), and the deletion of the pressure transfer ring. Evaluation of the insulation from this test demonstrated it to be much smoother through the OD radius than most previous flight inhibitor regions. It also had fewer voids and case-to-insulation folds, but numerous defects were still occurring.

**Test No. 3** - This test was to develop an interim fix, making only moderate changes to the current process. The modifications to the normal processes were changes to the NBR patterns under the igniter mold ring to a one-piece full-circle pattern with one butt joint, matched skive joints of the three-dome base ply patterns, three-piece circumferential patterning cloths and breather cloths, and a new design (low profile) pressure transfer ring. Evaluation of the insulation from this test demonstrated it to have no voids or case-to-insulation folds. It did demonstrate a definite thinning impression at the pressure transfer ring edges around the entire interface of the insulation to pressure transfer ring. However, the insulation profile measurements only demonstrated one localized thin spot of 0.499-in. (versus 0.503-in. design min.).

**Test No. 4** - This test was to build the best inhibitor region using "lessons learned" from the three previous tests (Figure 2). The modifications to the normal process incorporated were: 1) one-piece full-circle NBR patterns with butt joints, 2) a change in the 5U pattern layup to eliminate 0.030-in. thickness of insulation from under the mold ring, and 3) use of matched skive joints on the three dome base ply patterns. NBR filler plies were added on two-thirds of the circumference of the OD extrusion (0.050-in. thick for 120 degrees and 0.100-in. thick for 120 degrees). In addition, a three-piece circumferential patterning cloth and breather cloth system was utilized, no pressure transfer ring was used, and the Chickopee breather was slit lengthwise in the radius area and terminated at the top of the radius area. A 10-oz polyester was used circumferentially on the inhibitor, extending down into the radius area.

**Result** - No bridging was observed during the vacuum bagging operation. Evaluation of the insulation from this test demonstrated it to be the most uniform forward dome inhibitor region fabricated in these tests. There were no folds or voids and the insulation thickness measurements showed a very uniform configuration.

## 2.0 CONCLUSIONS

1. Use of the pressure transfer ring contributed to low pressure under the forward dome inhibitor radius and thin insulation under its outer edges.
2. Excess rubber under the igniter mold ring was extruded outward into the inhibitor radius and local dome area causing a churning motion in the insulation during cure. This resulted in case-to-insulation surface folds and internal voids.
3. The fan-type pattern and breather cloth and the continuous Chickopee strips contributed to a bridging problem in the forward dome inhibitor area.
4. Insulation overlap and overfill (5U) requirements in the circular plies (under the mold ring) contributed to the material overload condition.
5. Overlap requirements of the three base plies combined with material extruded (Item 2) caused bumps in the cured insulation that interfered with ultrasonic inspection of the igniter boss dome region.
6. The three-piece (CAD/CAM circumferencial design [Figure 1]) patterning/breather cloth system allowed the necessary movement during debulk to form a defect-free inhibitor region.
7. Proper vacuum bagging techniques are essential to ensure a defect-free radius region in the forward dome inhibitor.

### 3.0 RECOMMENDATIONS

It is recommended that:

1. Pressure transfer rings be eliminated during insulation cure of forward segments.
2. The 5U rubber layup drawing of the forward segment be changed to 1) eliminate overlap joints in the circular plies under the igniter mold ring, 2) reduce the amount of rubber under the igniter mold ring, 3) eliminate overlap joints, and 4) incorporate matched skive joints on the three base plies of insulation.
3. The three-piece (CAD/CAM circumferential design) patterning/breather cloths be incorporated to replace the fan-type design patterning/breather cloths in the vacuum bagging operation of the forward segment.
4. The vacuum bagging operation, which includes the installation of the patterning and breather cloths through final vacuum draw down of the vacuum bag, be recognized as critical operations that must be performed or critically overseen by an experienced vacuum bag specialist. Responsibility for this operation being acceptable must be bought off by a qualified Manufacturing person and a Quality Assurance person.

### 4.0 DISCUSSION

#### 4.1 General

All forward domes used in this study were scrap flight domes insulated in the vertical position and were processed without the use of Chemlok 205 primer or Chemlok 233 adhesive. The Chemlok system was omitted to allow quick removal of the insulation from the dome for dissection and evaluation and for quick turn-around of the forward domes for promptness in conducting this study. The aft edge of the vacuum bag was sealed just beyond the layup on the inside of the forward dome. The forward edge of the vacuum bag extended through the dome igniter port and was sealed to the outside of the dome. Vacuum was applied through the igniter mold ring only. The insulated test assemblies were cured using an autoclave cure cycle established by taking the average rampup, holds, and cooldown cycle from the cure cycle of five production forward segments (Figure 3).

Immediately after cure, the insulation was cut into quarters and removed from each test dome. Approximately 20 inches of the outer region were cut off and discarded. The quarters containing the inhibitor region were sent to Building Z-12 and dissected into approximately 4.5 degree parallel sections. The defects were mapped and are included separately for PSA-1 and PSA-2 test domes (Attachments I and II). No defects (voids or folds) were found in PSA-3 and PSA-4. The insulation thickness profile was then measured for each of the dissected sections from approximately three inches out from the igniter boss every half inch to eight inches from the boss. The tables containing these individual measurements are included as Attachments III through VI. These thickness profile measurements are demonstrated in a surface representation for each test dome in Figures 4, 5, 6, and 7.

#### 4.2 Individual Tests

##### TEST DOME NO. 1 (PSA-1)

The first test dome was insulated to simulate the worst condition found in flight segments. The objective of this dome was to duplicate 1) voids within the insulation, 2) case-to-insulation surface folds, and 3) thin insulation on the dome surface using baseline procedures and standards of RSRM production processing.

1. Forward dome was received and cleaned.
2. Paint was applied
3. Teflon tape was applied to outer edge of layup area to allow insulation removal after cure.
4. Layup was performed per normal process.
5. Current "fan" application patterning and breather cloths were used. Bridging was assured to simulate worst condition of normal process.
6. The normal production pressure transfer ring was installed over the bridged breather cloth.
7. Eight each 8- to 10-in. wide strips of Chickopee (breather) were extended up the dome, over the pressure transfer ring, up the inhibitor, and into the igniter mold inside diameter.

Post-Cure Observations

Upon insulation removal from the dome, multiple case-to-insulation folds were visually detectable. Mapping after dissection determined voids and unfolds in 67 locations (Attachment I). This was by far the highest number of defects of any dome region in this test. Profile measurements demonstrated that thinning of insulation was obvious in the region six inches from boss (Attachment III and Figure 4). This coincides with the location of the outer tip of the pressure transfer ring. The overall profile of insulation thickness was quite erratic. Figure 4 provides a graphic circumferential profile of thickness measurements at 3.5 and 6.0 inches outboard the igniter boss. This dome did demonstrate all the desired problems that had been present on any flight segment evaluated.

TEST DOME NO. 2 (PSA-2)

In an attempt to eliminate the void, fold, and thin insulation problems, the next dome was fabricated as follows:

1. Forward dome was received and cleaned.
2. Teflon tape was applied to outer edge of layup area to allow insulation removal after cure
3. Layup was performed per normal process except two 0.100-in. thick plies were laid over the OD extrusion from 0 to 180 degrees.
4. CAD/CAM designed (three-piece circumferential) patterning cloth and breather cloth layups were used in the inhibitor radius area (extending out onto the dome approximately 11 inches) to allow slippage (eliminate bridging) during intended cure cycle debulking (Figure 1).
5. No pressure transfer ring was used.
6. Eight each 8- to 10-in. strips of Chickopee (breather) extended up the dome, up the inhibitor, and over the igniter mold to the inside diameter
7. Normal vacuum bagging procedure was used.
8. Normal autoclave cure was followed.

Post-Cure Observations

Upon insulation removal from the dome, several case-to-insulation folds were visibly detectable. The radius area was smoother than previous flight forward dome inhibitor regions. Defect mapping after dissection demonstrated far fewer voids and folds than the first test, but the defects were present intermittently for the full circumference (Attachment II). Profile measurements demonstrated some movement of insulation from the mold region to the radius area and just beyond (Attachment IV and Figure 5). A graphic circumferential thickness profile at four and six inches from the igniter boss is shown on Figure 5.

TEST DOME NO. 3 (PSA-3)

The third test dome was used to develop an interim fix to keep the production of segments going. Only moderate changes to the current design were incorporated.

1. Forward dome was received and cleaned.
2. Teflon tape was applied to outer edge of the layup area to allow insulation removal after cure
3. Normal layup was followed except patterns under the mold ring were full circle and matched skived on the three base pattern joints.
4. CAD/CAM design (three-piece circumferential) patterning and breather cloth were used in the radius area
5. New low-profile (maximum thickness of 0.250-in. thick) pressure transfer ring was installed over the three-piece breather cloth.

NOTE

This pressure transfer ring was fabricated on the fiberglass mold that previous production shop aid pressure transfer rings were fabricated on. The ID surfaces of the pressure ring are mold-formed and the OD surface is layup profile/vacuum bag formed.

6. The eight each 8- to 10-in. strips of Chickopee (breather) were extended through the radius from the dome and down from the inhibitor, slit into one-in. wide tabs and overlapped for approximately 3.5 inches.

7. Normal vacuum bagging procedures were followed, taking extra care to ensure there was no bridging in the radius area.
8. Normal autoclave cure procedure was followed.

Post-Cure Observations

The inhibitor-to-dome radius was better formed on this test dome than the two previous test domes. There were no voids or folds in the insulation from this test. There was a definite thinning of insulation for the full circumference where the pressure transfer ring terminated above the insulation. The thickness profile graph (Figure 6) demonstrates this impression in the insulation dome area. There was a thin area of 0.499-in. minimum thickness in the 5.5-in. from the igniter boss. Attachment V is included to provide the individual thickness measurements from this test. The circumferential profile is provided in graph form (Figure 6) for comparison.

TEST DOME NO. 4 (PSA-4)

The fourth test dome was built using the "lessons learned" on the previous three tests to build the best forward dome inhibitor region possible.

1. Forward dome was received and cleaned.
2. Teflon tape was applied to outer edge of layup area to allow insulation removal after cure.
3. Normal layup was followed except patterns under the mold ring were one-piece full-circle and with matched skived edges on the three base pattern joints.
4. CAD/CAM design (three piece circumferencial) patterning cloth and breather cloth was used in the radius area.
5. No pressure transfer ring.
6. The eight each 8- to 10-in. strips of Chickopee cloth (breather) were extended from the dome through the radius and had approximately 3.5 inches slit into approximately one-inch wide strips.
7. The inhibitor was wrapped with two layers of polyester cloth extending from the radius area over the top of the igniter mold ring.

8. Normal vacuum bagging procedures were followed, taking extra care to ensure there was no bridging in the radius area.
9. Normal autoclave cure was followed.

Post-Cure Observations

There were no voids or folds in the insulation from this test dome. The entire radius and thickness profile was the most uniform of these tests (Figure 7). Insulation thickness measurements (Attachment VI) show a smooth configuration with an average thickness of  $0.573 \pm 0.010$ -in. There was one local thin spot of 0.539-in. (versus 0.503-in. design min.).

The combination of changes incorporated in this test dome was responsible for the control of thickness and elimination of defects. Therefore, it is recommended that the changes incorporated in this forward dome be incorporated into production forward dome inhibitor region insulation operations.

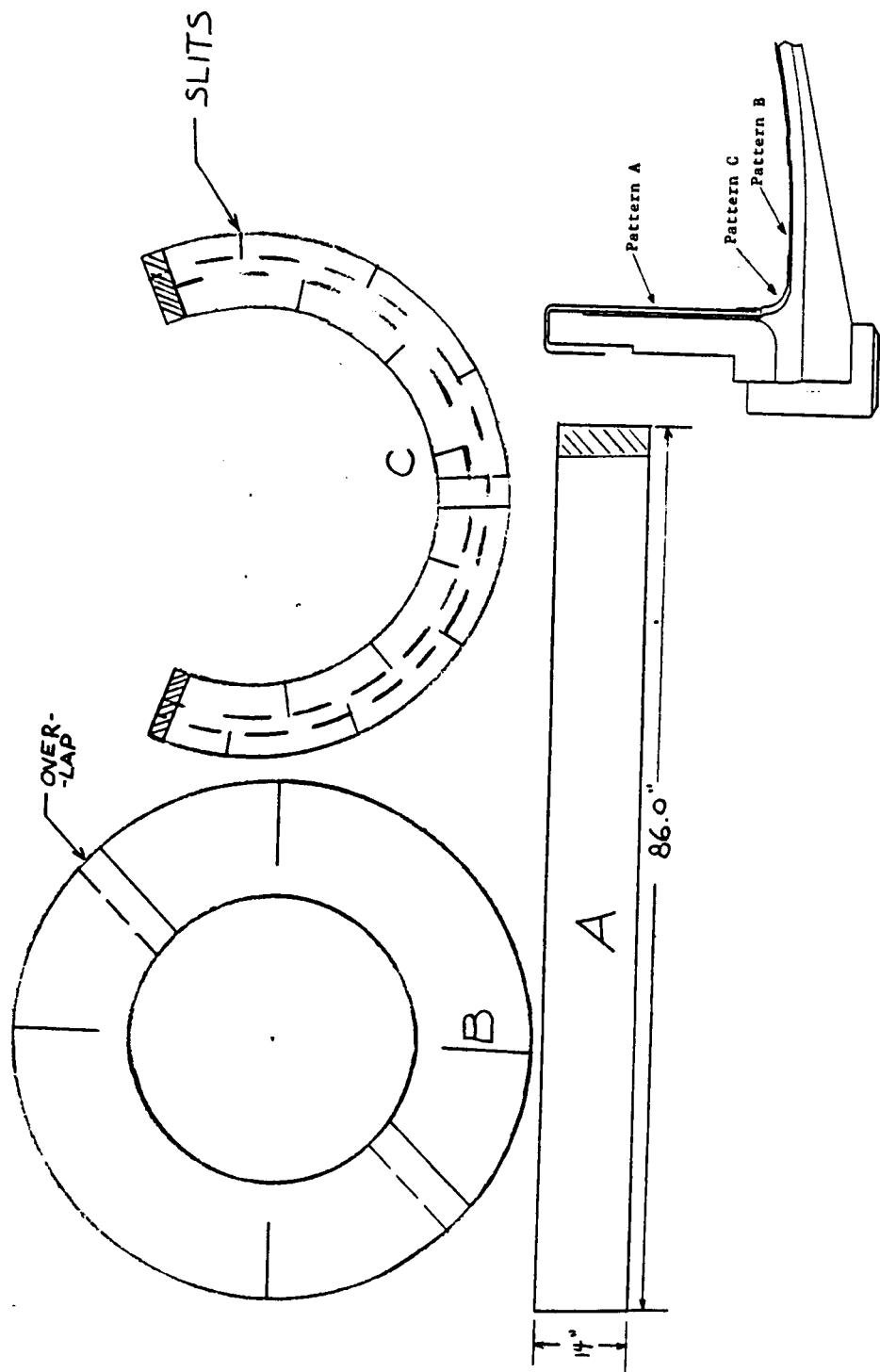


Figure 1. Three-Piece Patterning/Breather Cloth Patterns

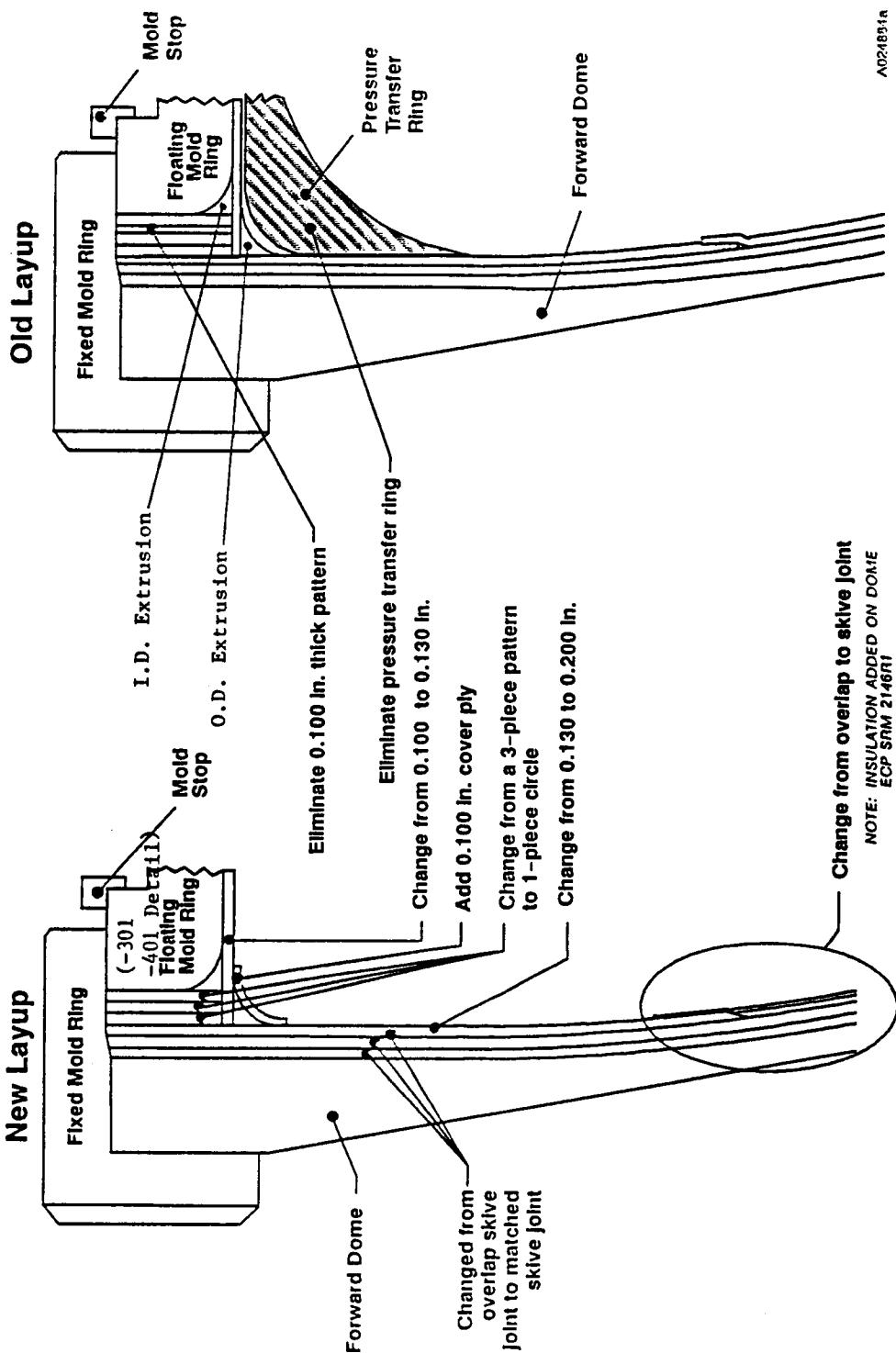


Figure 2. Insulation Layup Changes

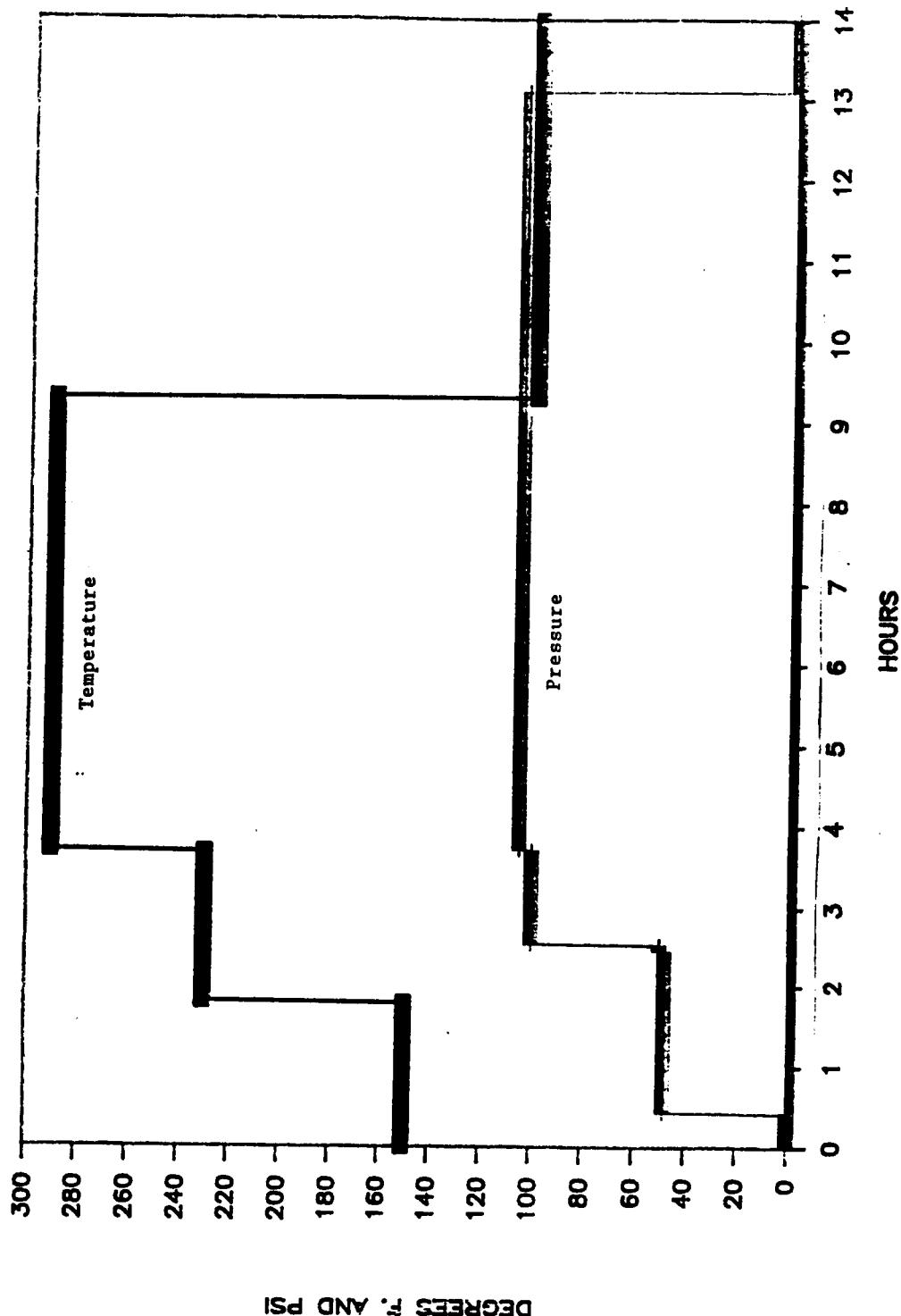


Figure 3. Typical Forward Segment, Insulation Cure Cycle

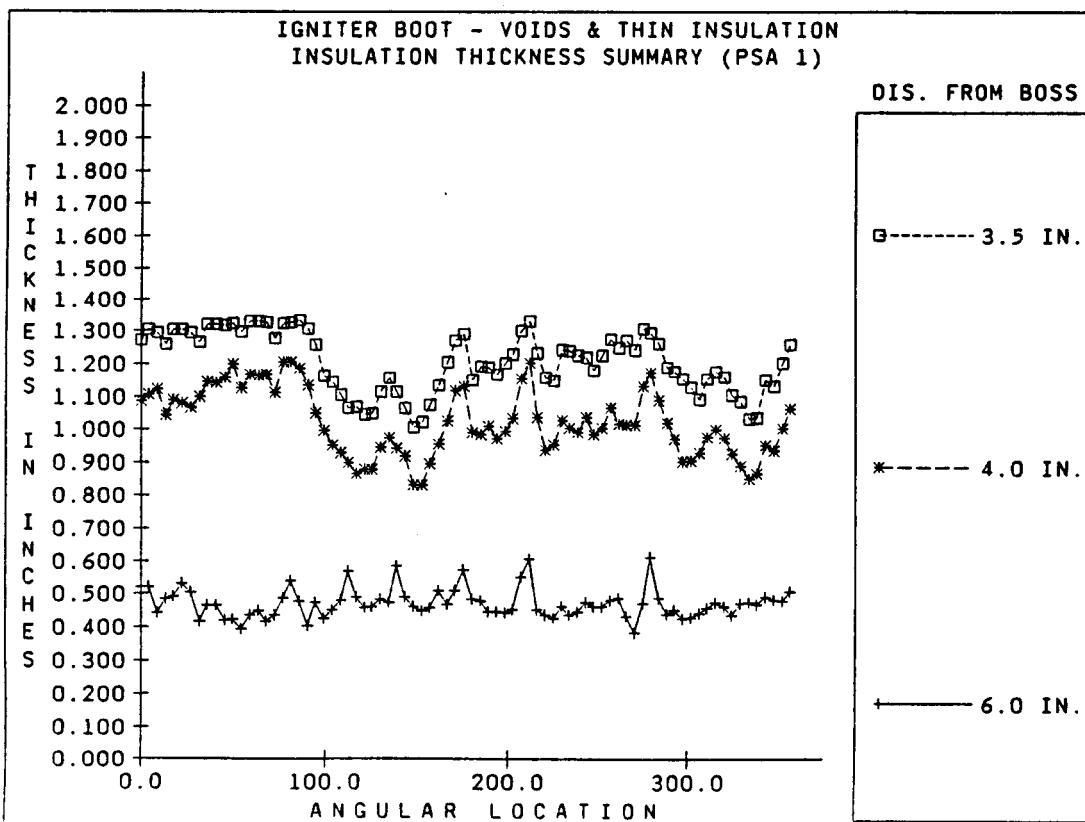
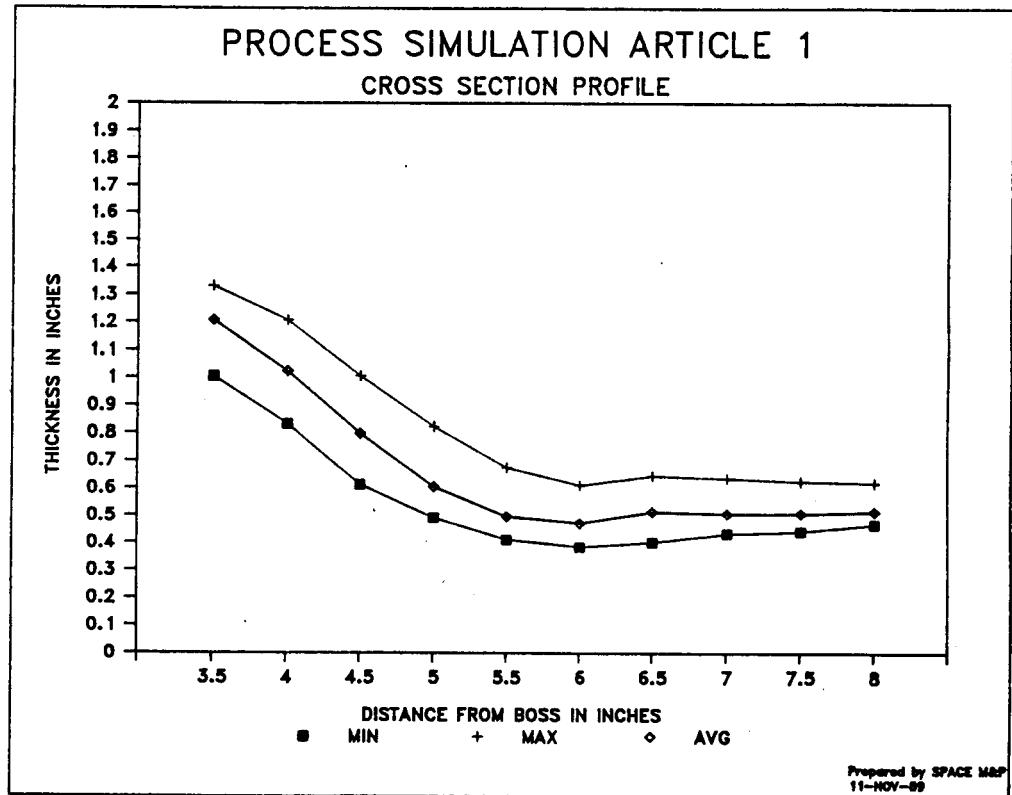


Figure 4. PSA-1 Thickness and Average Circumferential Profiles

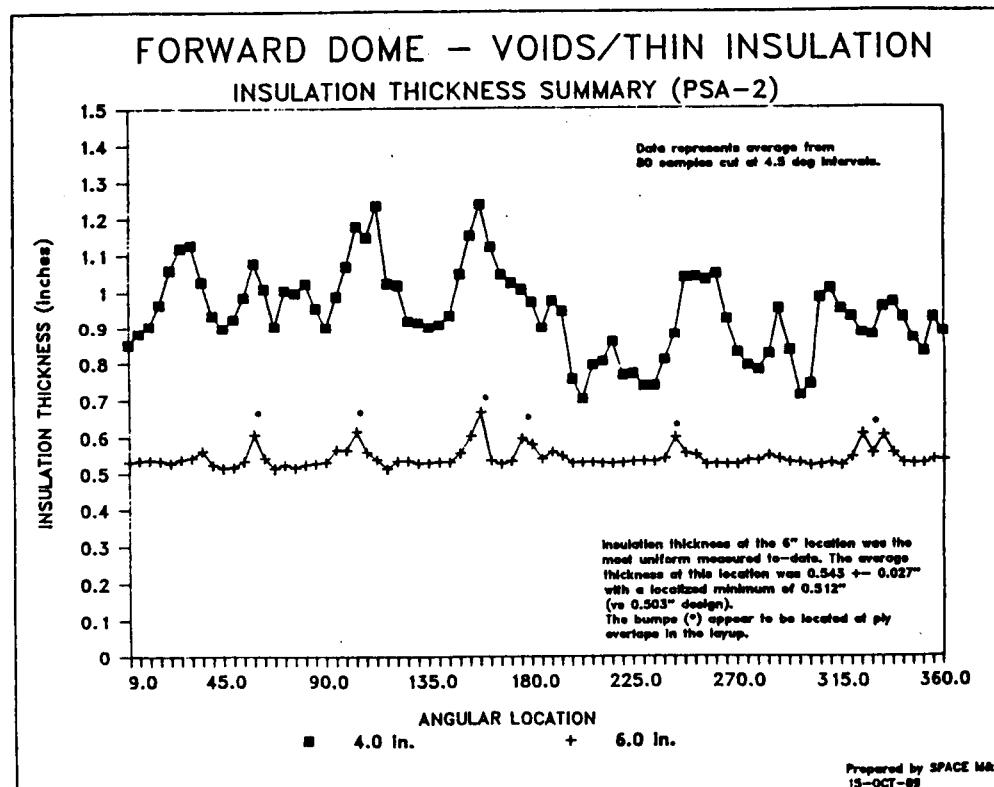
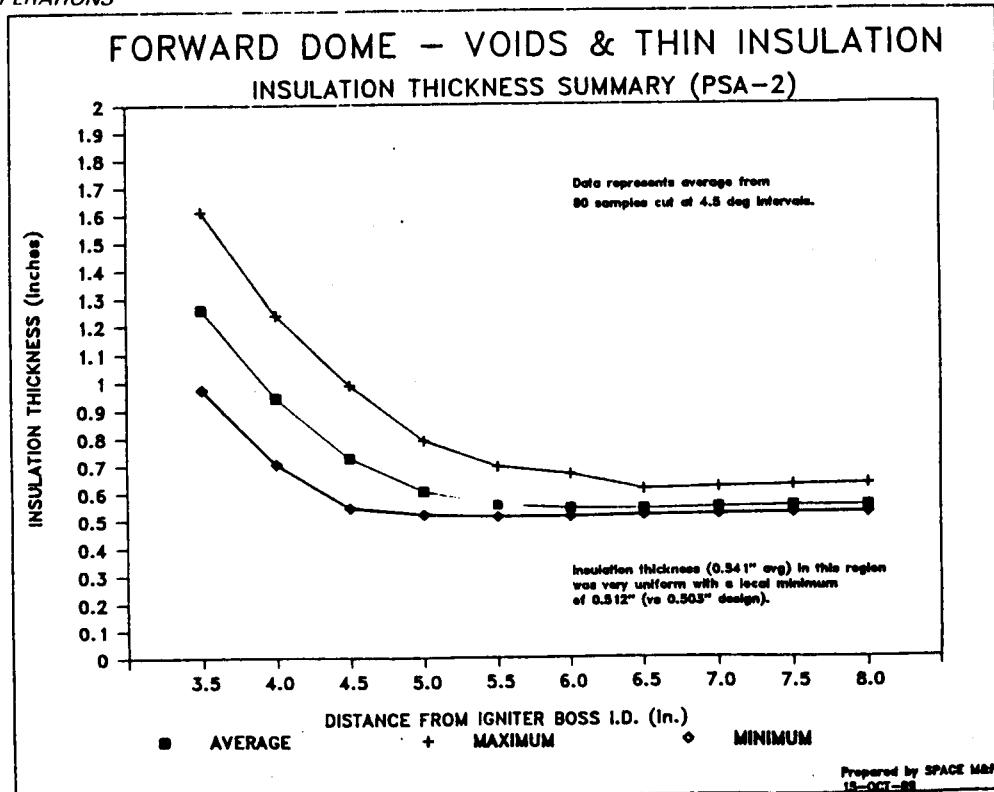


Figure 5. PSA-2 Thickness and Average Circumferential Profiles

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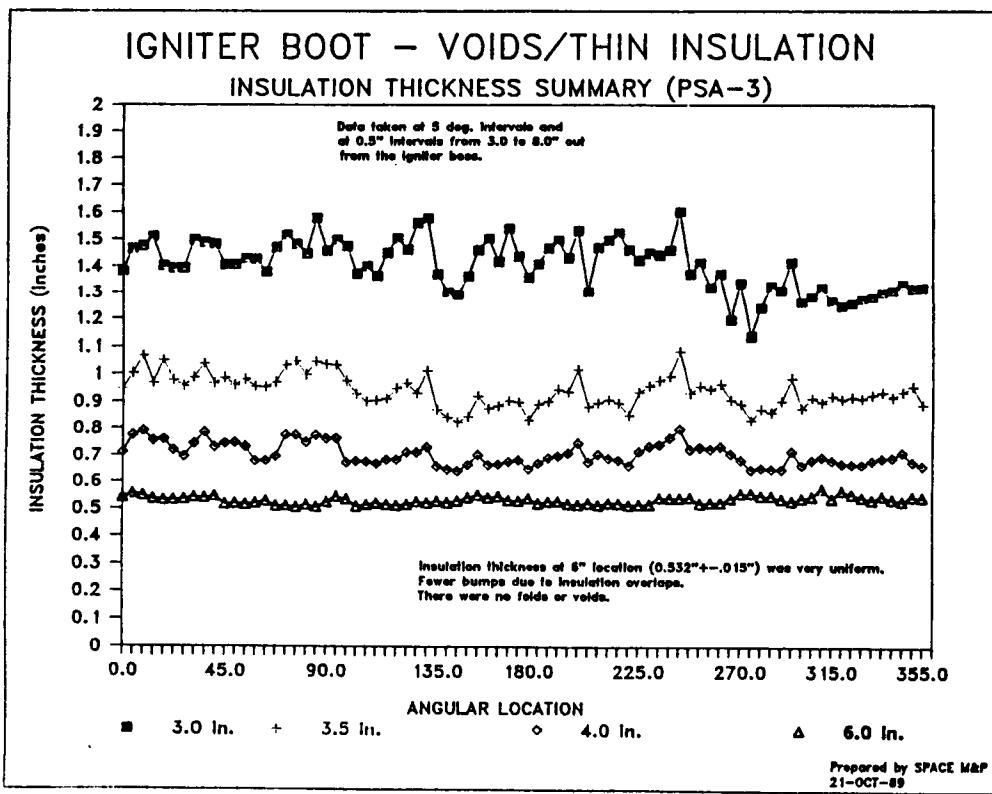
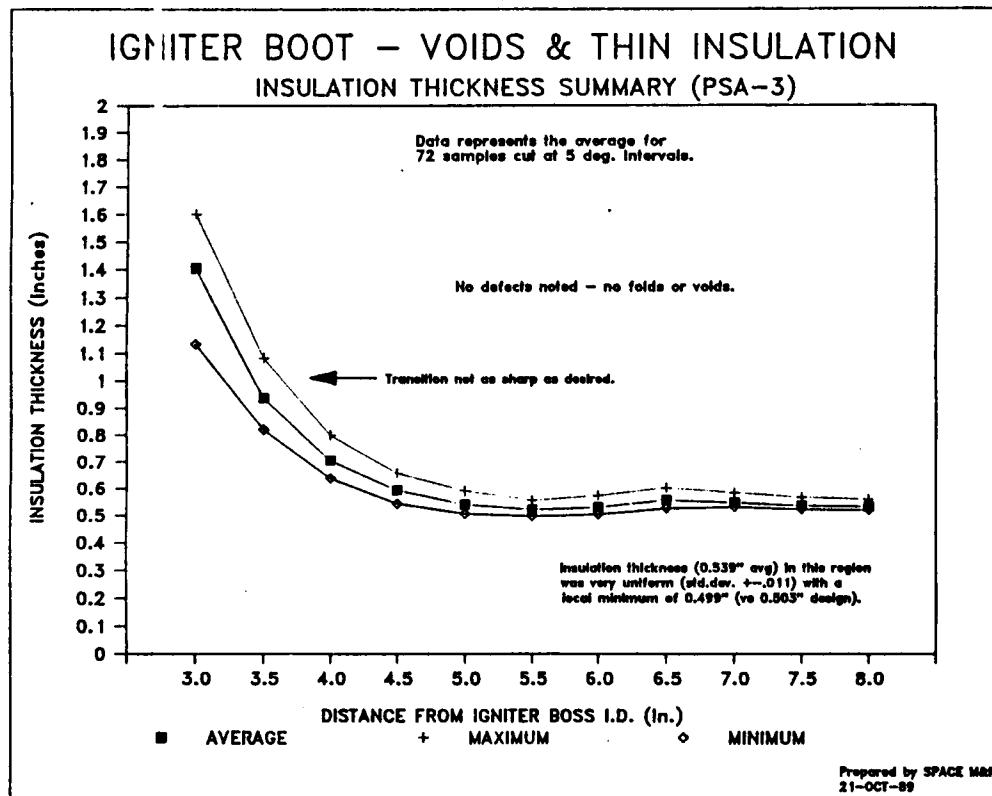


Figure 6. PSA-3 Thickness and Average Circumferential Profiles  
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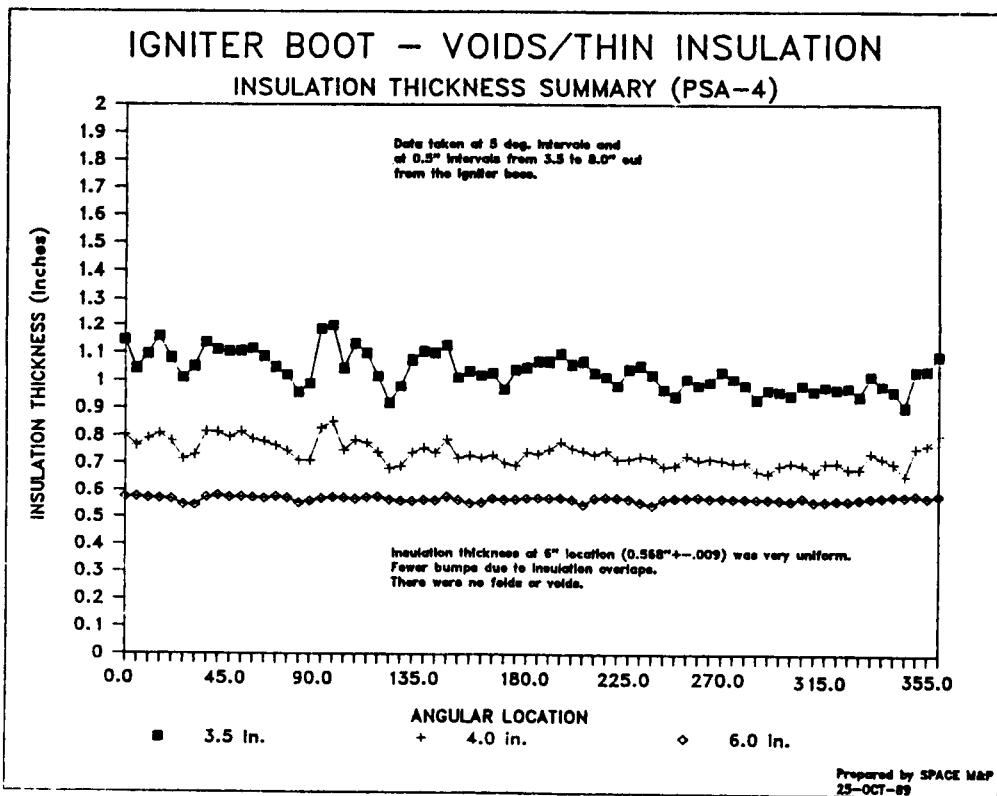
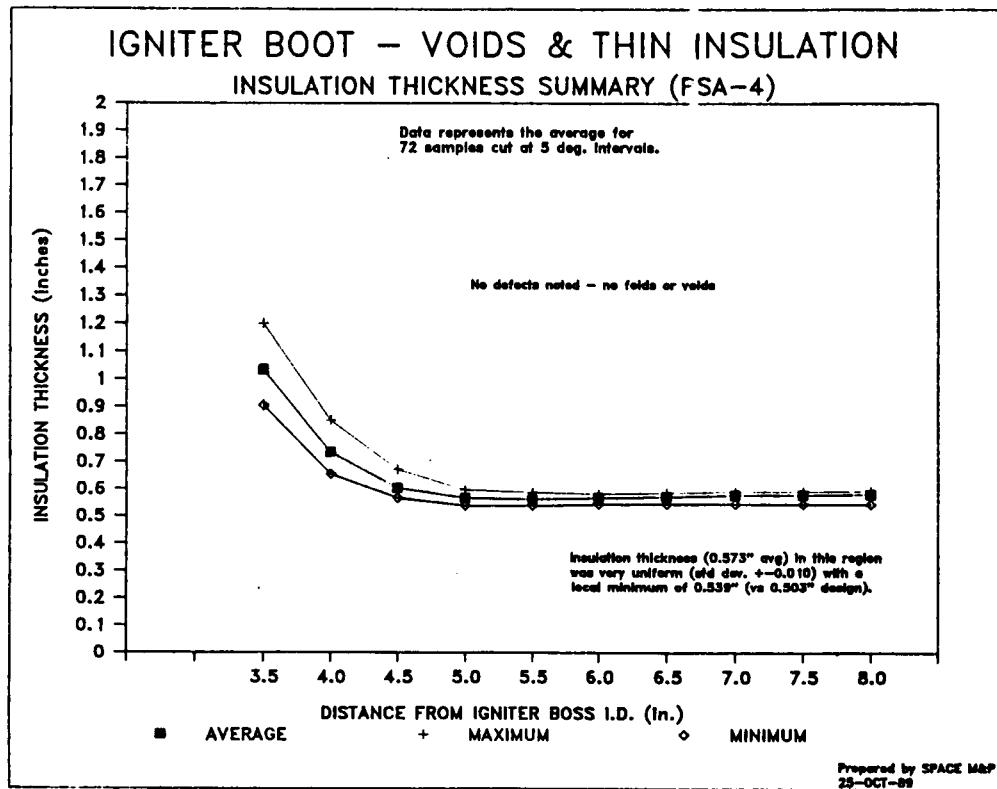
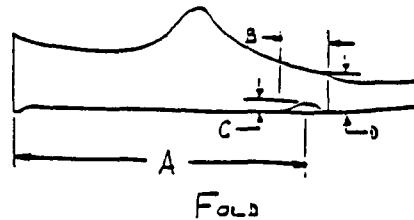
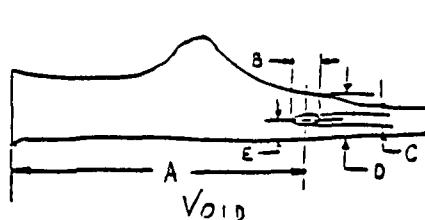


Figure 7. PSA-4 Thickness and Average Circumferential Profiles

ATTACHMENT I. PSA-1 Defect Location Chart

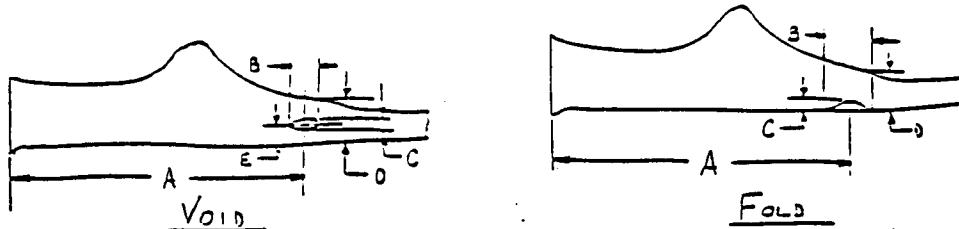


SEGMENT ALIAS: PSA 1

DATE: 10/10/89

| NO. | DEG.<br>LOCATION |      |     |     |      |     | TYPE<br>VOID/FOLD |
|-----|------------------|------|-----|-----|------|-----|-------------------|
|     |                  | A    | B   | C   | D    | E   |                   |
| 1   | 0                | .380 | .11 | .08 | .118 | .38 | VOID              |
| 2   | 0                | .408 | .10 | .07 | .108 | .46 | VOID              |
| 3   | 0                | .432 | .17 | .06 | .196 |     | FOLD              |
| 4   | 4.5              | .379 | .11 | .06 | .108 | .98 | VOID              |
| 5   | 4.5              | .401 | .07 | .07 | .118 | .36 | VOID              |
| 6   | 4.5              | .436 | .18 | .06 | .98  |     | FOLD              |
| 7   | 4.5              | .390 | .12 | .16 | .108 | .42 | VOID              |
| 8   | 9                | .388 | .08 | .06 | .110 | .50 | VOID              |
| 9   | 9                | .390 | .10 | .09 | .101 | .47 | VOID              |
| 10  | 9                | .426 | .12 | .06 | .88  |     | FOLD              |
| 11  | 13.5             | .429 | .17 | .07 | .102 |     | FOLD              |
| 12  | 18               | .412 | .08 | .05 | .98  |     | FOLD              |
| 13  | 36               | .388 | .09 | .07 | .103 |     | FOLD              |
| 14  | 40.5             | .381 | .14 | .11 | .118 |     | FOLD              |
| 15  | 45               | .392 | .22 | .19 | .116 |     | FOLD              |
| 16  | 49.5             | .372 | .13 | .08 | .121 | .16 | VOID              |
| 17  | 49.5             | .394 | .41 | .29 | .106 |     | FOLD              |
| 18  | 54               | .393 | .40 | .19 | .102 |     | FOLD              |
| 19  | 58.5             | .396 | .46 | .22 | .111 |     | FOLD              |

ATTACHMENT I. PSA-1 Defect Location Chart (Continued)

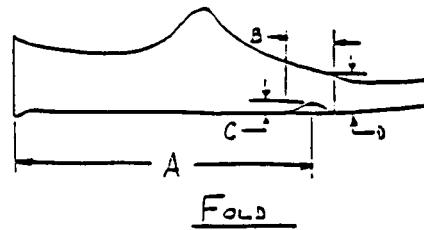
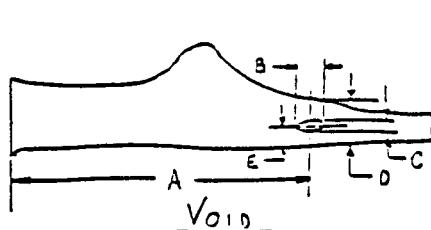


SEGMENT ALIAS: PSA 1

DATE: 10/10/89

| NO. | DEG.<br>LOCATION | A    | B   | C   | D    | E   | TYPE<br>VOID/FOLD |
|-----|------------------|------|-----|-----|------|-----|-------------------|
| 20  | 58.5             | 3.97 | .42 | .20 | 1.08 |     | FOLD              |
| 21  | 63               | 3.94 | .38 | .16 | 1.17 |     | FOLD              |
| 22  | 67.5             | 4.11 | .21 | .10 | 1.06 |     | FOLD              |
| 23  | 72               | 4.21 | .20 | .27 | 1.07 | .42 | VOID              |
| 24  | 76.5             | 4.22 | .19 | .30 | 1.08 | .40 | VOID              |
| 25  | 76.5             | 4.32 | .10 | .09 | 1.09 | .61 | VOID              |
| 26  | 76.5             | 4.11 | .42 | .12 | 1.12 |     | FOLD              |
| 27  | 81               | 4.30 | .21 | .06 | 1.11 | .58 | VOID              |
| 28  | 81               | 4.04 | .16 | .10 | 1.18 |     | FOLD              |
| 29  | 81               | 4.34 | .31 | .41 | 1.08 | .57 | VOID              |
| 30  | 85.5             | 4.32 | .41 | .38 | 1.10 | .60 | VOID              |
| 31  | 85.5             | 3.93 | .31 | .20 | 1.10 |     | FOLD              |
| 32  | 85.5             | 4.44 | .14 | .08 | .94  | .80 | VOID              |
| 33  | 90               | 4.40 | .16 | .10 | .98  | .74 | VOID              |
| 34  | 130.5            | 4.12 | .12 | .10 | .90  | .44 | VOID              |
| 35  | 135              | 4.02 | .16 | .08 | 1.04 |     | FOLD              |
| 36  | 144              | 3.82 | .18 | .08 | .90  |     | FOLD              |
| 37  | 148.5            | 3.84 | .12 | .06 | .90  |     | FOLD              |
| 38  | 171              | 4.24 | .26 | .17 | 1.07 | .60 | VOID              |

ATTACHMENT I. PSA-1 Defect Location Chart (Continued)

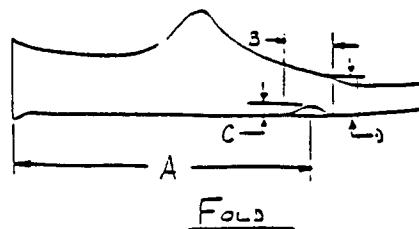
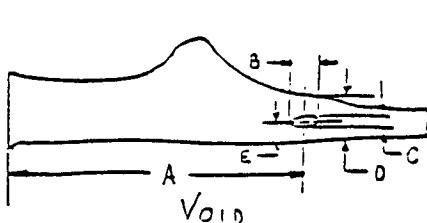


SEGMENT ALIAS: PSA1

DATE: 10/10/89

| NO. | DEG.<br>LOCATION | A    | B   | C   | D    | E   | TYPE<br>VOID/FOLD |
|-----|------------------|------|-----|-----|------|-----|-------------------|
| 39  | 175.5            | 4.21 | .31 | .21 | 1.04 | .54 | Void              |
| 40  | 175.5            | 3.81 | .43 | .18 | 1.06 | —   | Fold              |
| 41  | 175.5            | 4.01 | .14 | .04 | .98  | .38 | Void              |
| 42  | 180              | 4.06 | .15 | .06 | .94  | .36 | Void              |
| 43  | 211.5            | 3.99 | .18 | .10 | 1.09 | —   | Fold              |
| 44  | 211.5            | 4.08 | .37 | .20 | 1.18 | .15 | Void              |
| 45  | 211.5            | 4.09 | .06 | .08 | 1.17 | .75 | Void              |
| 46  | 211.5            | 3.82 | .14 | .07 | 1.24 | .37 | Void              |
| 47  | 211.5            | 3.99 | .19 | .08 | 1.20 | .54 | Void              |
| 48  | 211.5            | 4.38 | .06 | .06 | 1.00 | .45 | Void              |
| 49  | 216              | 4.02 | .30 | .19 | 1.16 | .17 | Void              |
| 50  | 216              | 3.81 | .07 | .07 | 1.24 | .42 | Void              |
| 51  | 238.5            | 3.80 | .05 | .03 | 1.01 | —   | Fold              |
| 52  | 243              | 3.81 | .07 | .03 | 1.08 | —   | Fold              |
| 53  | 247.5            | 3.73 | .12 | .04 | 1.07 | —   | Fold              |
| 54  | 252              | 3.70 | .24 | .12 | 1.14 | —   | Fold              |
| 55  | 256.5            | 3.72 | .31 | .19 | 1.10 | —   | Fold              |
| 56  | 261              | 3.78 | .48 | .23 | 1.07 | —   | Fold              |
| 57  | 265              | 3.94 | .23 | .12 | 1.08 | —   | Fold              |

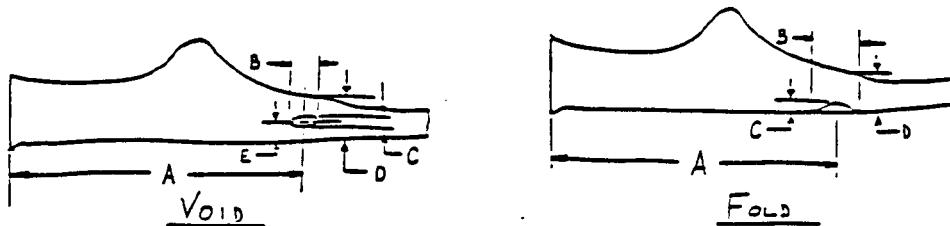
**ATTACHMENT I. PSA-1 Defect Location Chart (Continued)**



SEGMENT ALIAS: *PSA1*

DATE: 10/10/89

ATTACHMENT II. PSA-2 Defect Location Chart



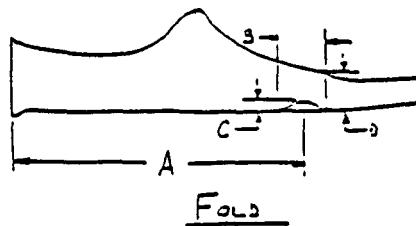
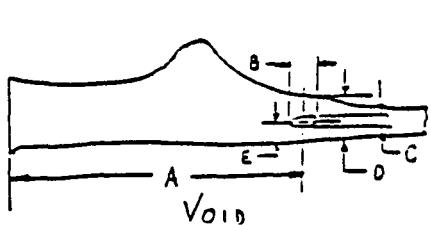
SEGMENT ALIAS:

PSA - 2

DATE: 10/17/89

| NO. | DEG.<br>LOCATION | A    | B   | C   | D    | E   | TYPE<br>VOID/FOLD |
|-----|------------------|------|-----|-----|------|-----|-------------------|
| 1   | 27               | .440 | .22 | .09 | .83  |     | VOID              |
| 2   | 27               | .445 | .12 | .08 | .84  | .48 | VOID              |
| 3   | 31.5             | .450 | .21 | .11 | .21  | .47 | VOID              |
| 4   | 73               | .432 | .05 | .05 | .77  | .38 | VOID              |
| 5   | 81               | .433 | .05 | .07 | .75  | .36 | VOID              |
| 6   | 108              | .456 | .28 | .05 | .84  |     | FOLD              |
| 7   | 112.5            | .451 | .23 | .06 | .84  |     | FOLD              |
| 8   | 112.5            | .476 | .10 | .04 | .77  | .12 | VOID              |
| 9   | 112.5            | .459 | .10 | .02 | .82  | .21 | VOID              |
| 10  | 157.5            | .449 | .12 | .08 | .87  | .21 | VOID              |
| 11  | 157.5            | .470 | .10 | .05 | .77  |     | FOLD              |
| 12  | 157.5            | .403 | .13 | .05 | .11  |     | VOID              |
| 13  | 162              | .440 | .14 | .06 | .83  | .18 | VOID              |
| 14  | 162              | .460 | .12 | .05 | .79  |     | FOLD              |
| 15  | 162              | .380 | .07 | .03 | .11  |     | FOLD              |
| 16  | 247.5            | .401 | .10 | .02 | .92  |     | FOLD              |
| 17  | 256              | .380 | .06 | .03 | .120 |     | FOLD              |
| 18  | 306              | .366 | .09 | .04 | .114 |     | FOLD              |
| 19  | 306              | .422 | .18 | .14 | .90  | .48 | VOID              |

**ATTACHMENT II. PSA-2 Defect Location Chart (Continued)**



SEGMENT ALIAS: *PSA* 2

DATE: 10/17/89

ATTACHMENT III. PSA-1 Thickness Measurements

| LOCATION | INCHES FROM BOSS |       |       |       |       |       |       |       |       |       |
|----------|------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|          | 3.5              | 4.0   | 4.5   | 5.0   | 5.5   | 6.0   | 6.5   | 7.0   | 7.5   | 8.0   |
| 0.0      | 1.270            | 1.086 | 0.849 | 0.608 | 0.502 | 0.521 | 0.529 | 0.511 | 0.504 | 0.513 |
| 4.5      | 1.303            | 1.105 | 0.889 | 0.667 | 0.546 | 0.520 | 0.561 | 0.516 | 0.493 | 0.509 |
| 9.0      | 1.295            | 1.122 | 0.885 | 0.620 | 0.479 | 0.444 | 0.501 | 0.479 | 0.471 | 0.494 |
| 13.5     | 1.258            | 1.044 | 0.818 | 0.608 | 0.507 | 0.485 | 0.511 | 0.503 | 0.505 | 0.508 |
| 18.0     | 1.304            | 1.089 | 0.851 | 0.639 | 0.510 | 0.493 | 0.497 | 0.487 | 0.494 | 0.505 |
| 22.5     | 1.304            | 1.079 | 0.810 | 0.590 | 0.501 | 0.532 | 0.538 | 0.557 | 0.537 | 0.582 |
| 27.0     | 1.294            | 1.067 | 0.782 | 0.582 | 0.477 | 0.506 | 0.531 | 0.522 | 0.527 | 0.540 |
| 31.5     | 1.263            | 1.098 | 0.828 | 0.583 | 0.425 | 0.419 | 0.492 | 0.478 | 0.488 | 0.503 |
| 36.0     | 1.320            | 1.145 | 0.900 | 0.653 | 0.516 | 0.467 | 0.491 | 0.478 | 0.483 | 0.494 |
| 40.5     | 1.320            | 1.141 | 0.882 | 0.636 | 0.507 | 0.464 | 0.483 | 0.468 | 0.464 | 0.496 |
| 45.0     | 1.318            | 1.159 | 0.893 | 0.592 | 0.445 | 0.421 | 0.468 | 0.456 | 0.474 | 0.486 |
| 49.5     | 1.324            | 1.200 | 0.971 | 0.664 | 0.486 | 0.424 | 0.468 | 0.458 | 0.462 | 0.475 |
| 54.0     | 1.296            | 1.125 | 0.889 | 0.637 | 0.456 | 0.396 | 0.453 | 0.453 | 0.464 | 0.483 |
| 58.5     | 1.329            | 1.167 | 0.919 | 0.657 | 0.495 | 0.435 | 0.470 | 0.477 | 0.476 | 0.495 |
| 63.0     | 1.330            | 1.164 | 0.927 | 0.669 | 0.522 | 0.450 | 0.468 | 0.459 | 0.470 | 0.485 |
| 67.5     | 1.325            | 1.167 | 0.895 | 0.641 | 0.478 | 0.419 | 0.479 | 0.482 | 0.500 | 0.523 |
| 72.0     | 1.279            | 1.113 | 0.875 | 0.658 | 0.499 | 0.437 | 0.488 | 0.482 | 0.475 | 0.507 |
| 76.5     | 1.324            | 1.208 | 1.001 | 0.786 | 0.595 | 0.488 | 0.521 | 0.493 | 0.489 | 0.494 |
| 81.0     | 1.328            | 1.205 | 1.002 | 0.802 | 0.631 | 0.539 | 0.571 | 0.515 | 0.507 | 0.508 |
| 85.5     | 1.332            | 1.187 | 0.989 | 0.759 | 0.576 | 0.477 | 0.503 | 0.473 | 0.467 | 0.476 |
| 90.0     | 1.306            | 1.135 | 0.904 | 0.701 | 0.515 | 0.404 | 0.448 | 0.434 | 0.443 | 0.469 |
| 94.5     | 1.257            | 1.051 | 0.835 | 0.670 | 0.530 | 0.477 | 0.520 | 0.508 | 0.510 | 0.510 |
| 99.0     | 1.165            | 0.999 | 0.781 | 0.607 | 0.484 | 0.426 | 0.482 | 0.477 | 0.483 | 0.496 |
| 103.5    | 1.144            | 0.954 | 0.776 | 0.600 | 0.483 | 0.451 | 0.496 | 0.502 | 0.502 | 0.508 |
| 108.0    | 1.107            | 0.931 | 0.763 | 0.616 | 0.515 | 0.483 | 0.509 | 0.519 | 0.509 | 0.512 |
| 112.5    | 1.068            | 0.901 | 0.733 | 0.593 | 0.558 | 0.571 | 0.601 | 0.625 | 0.622 | 0.614 |
| 117.0    | 1.069            | 0.870 | 0.686 | 0.541 | 0.478 | 0.492 | 0.536 | 0.558 | 0.564 | 0.577 |
| 121.5    | 1.049            | 0.883 | 0.705 | 0.546 | 0.474 | 0.460 | 0.506 | 0.521 | 0.522 | 0.526 |
| 126.0    | 1.050            | 0.883 | 0.686 | 0.549 | 0.473 | 0.461 | 0.508 | 0.520 | 0.520 | 0.520 |
| 130.5    | 1.114            | 0.946 | 0.773 | 0.612 | 0.517 | 0.486 | 0.543 | 0.520 | 0.520 | 0.521 |
| 135.0    | 1.159            | 0.975 | 0.814 | 0.672 | 0.547 | 0.477 | 0.511 | 0.506 | 0.508 | 0.514 |
| 139.5    | 1.114            | 0.943 | 0.791 | 0.689 | 0.608 | 0.587 | 0.636 | 0.638 | 0.626 | 0.620 |
| 144.0    | 1.065            | 0.919 | 0.762 | 0.619 | 0.517 | 0.493 | 0.573 | 0.557 | 0.558 |       |
| 148.5    | 1.007            | 0.834 | 0.623 | 0.499 | 0.447 | 0.462 | 0.531 | 0.522 | 0.524 | 0.526 |
| 153.0    | 1.023            | 0.833 | 0.615 | 0.492 | 0.435 | 0.451 | 0.520 | 0.517 | 0.522 | 0.528 |
| 157.5    | 1.078            | 0.898 | 0.696 | 0.535 | 0.464 | 0.459 | 0.516 | 0.519 | 0.525 | 0.528 |
| 162.0    | 1.135            | 0.956 | 0.757 | 0.603 | 0.522 | 0.510 | 0.551 | 0.540 | 0.525 | 0.530 |
| 166.5    | 1.205            | 1.028 | 0.805 | 0.619 | 0.479 | 0.469 | 0.499 | 0.505 | 0.508 | 0.518 |
| 171.0    | 1.272            | 1.119 | 0.905 | 0.683 | 0.544 | 0.512 | 0.556 | 0.535 | 0.537 | 0.550 |
| 175.5    | 1.290            | 1.133 | 0.955 | 0.749 | 0.619 | 0.574 | 0.571 | 0.514 | 0.495 | 0.501 |
| 180.0    | 1.152            | 0.991 | 0.769 | 0.580 | 0.486 | 0.487 | 0.530 | 0.511 | 0.510 | 0.516 |
| 184.5    | 1.195            | 0.985 | 0.767 | 0.585 | 0.500 | 0.480 | 0.501 | 0.496 | 0.496 | 0.509 |
| 189.0    | 1.192            | 1.012 | 0.755 | 0.568 | 0.474 | 0.448 | 0.507 | 0.501 | 0.505 | 0.512 |
| 193.5    | 1.167            | 0.972 | 0.747 | 0.549 | 0.459 | 0.446 | 0.519 | 0.519 | 0.529 | 0.537 |
| 198.0    | 1.202            | 0.996 | 0.772 | 0.558 | 0.468 | 0.442 | 0.523 | 0.524 | 0.534 | 0.543 |
| 202.5    | 1.228            | 1.033 | 0.830 | 0.608 | 0.492 | 0.453 | 0.482 | 0.492 | 0.499 | 0.505 |
| 207.0    | 1.301            | 1.153 | 0.923 | 0.716 | 0.601 | 0.550 | 0.561 | 0.572 | 0.575 | 0.583 |
| 211.5    | 1.330            | 1.203 | 1.007 | 0.823 | 0.676 | 0.605 | 0.610 | 0.563 | 0.529 | 0.521 |
| 216.0    | 1.234            | 1.037 | 0.789 | 0.575 | 0.468 | 0.452 | 0.515 | 0.541 | 0.528 | 0.517 |

ATTACHMENT III. PSA-1 Thickness Measurements (Continued)

| LOCATION | INCHES FROM BOSS |       |       |       |       |       |       |       |       |       |  |
|----------|------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|
| 220.5    | 1.157            | 0.938 | 0.691 | 0.497 | 0.430 | 0.436 | 0.474 | 0.479 | 0.482 | 0.495 |  |
| 225.0    | 1.147            | 0.952 | 0.669 | 0.494 | 0.417 | 0.426 | 0.479 | 0.504 | 0.506 | 0.514 |  |
| 229.5    | 1.243            | 1.029 | 0.760 | 0.588 | 0.484 | 0.464 | 0.495 | 0.498 | 0.505 | 0.512 |  |
| 234.0    | 1.238            | 1.004 | 0.754 | 0.543 | 0.462 | 0.436 | 0.494 | 0.492 | 0.502 | 0.519 |  |
| 238.5    | 1.225            | 0.992 | 0.749 | 0.564 | 0.455 | 0.445 | 0.512 | 0.499 | 0.500 | 0.513 |  |
| 243.0    | 1.218            | 1.037 | 0.795 | 0.603 | 0.485 | 0.476 | 0.525 | 0.507 | 0.502 | 0.506 |  |
| 247.5    | 1.179            | 0.984 | 0.734 | 0.550 | 0.460 | 0.462 | 0.487 | 0.487 | 0.496 | 0.513 |  |
| 252.0    | 1.227            | 1.005 | 0.753 | 0.563 | 0.468 | 0.461 | 0.497 | 0.493 | 0.504 | 0.512 |  |
| 256.5    | 1.275            | 1.067 | 0.818 | 0.608 | 0.507 | 0.482 | 0.488 | 0.491 | 0.498 | 0.504 |  |
| 261.0    | 1.248            | 1.017 | 0.742 | 0.574 | 0.493 | 0.487 | 0.513 | 0.517 | 0.512 | 0.513 |  |
| 265.5    | 1.270            | 1.015 | 0.745 | 0.569 | 0.466 | 0.432 | 0.438 | 0.465 | 0.471 | 0.496 |  |
| 270.0    | 1.241            | 1.015 | 0.753 | 0.518 | 0.411 | 0.384 | 0.402 | 0.434 | 0.460 | 0.482 |  |
| 274.5    | 1.306            | 1.131 | 0.903 | 0.685 | 0.548 | 0.474 | 0.483 | 0.505 | 0.488 | 0.495 |  |
| 279.0    | 1.293            | 1.173 | 0.965 | 0.779 | 0.661 | 0.611 | 0.646 | 0.592 | 0.569 | 0.564 |  |
| 283.5    | 1.261            | 1.089 | 0.885 | 0.666 | 0.536 | 0.490 | 0.551 | 0.509 | 0.492 | 0.497 |  |
| 288.0    | 1.190            | 1.020 | 0.775 | 0.587 | 0.471 | 0.440 | 0.500 | 0.485 | 0.488 | 0.499 |  |
| 292.5    | 1.177            | 0.972 | 0.726 | 0.555 | 0.468 | 0.453 | 0.516 | 0.509 | 0.511 | 0.521 |  |
| 297.0    | 1.154            | 0.906 | 0.666 | 0.508 | 0.432 | 0.427 | 0.513 | 0.496 | 0.498 | 0.514 |  |
| 301.5    | 1.129            | 0.908 | 0.689 | 0.505 | 0.433 | 0.430 | 0.514 | 0.501 | 0.501 | 0.506 |  |
| 306.0    | 1.091            | 0.930 | 0.691 | 0.535 | 0.456 | 0.443 | 0.524 | 0.503 | 0.503 | 0.504 |  |
| 310.5    | 1.154            | 0.979 | 0.750 | 0.584 | 0.486 | 0.459 | 0.519 | 0.498 | 0.494 | 0.506 |  |
| 315.0    | 1.178            | 1.003 | 0.819 | 0.616 | 0.516 | 0.477 | 0.530 | 0.507 | 0.507 | 0.506 |  |
| 319.5    | 1.159            | 0.977 | 0.737 | 0.563 | 0.486 | 0.463 | 0.529 | 0.514 | 0.509 | 0.511 |  |
| 324.0    | 1.105            | 0.926 | 0.700 | 0.520 | 0.436 | 0.438 | 0.504 | 0.507 | 0.506 | 0.513 |  |
| 328.5    | 1.085            | 0.890 | 0.696 | 0.535 | 0.471 | 0.472 | 0.535 | 0.513 | 0.517 | 0.517 |  |
| 333.0    | 1.034            | 0.851 | 0.612 | 0.492 | 0.434 | 0.475 | 0.539 | 0.521 | 0.524 | 0.526 |  |
| 337.5    | 1.037            | 0.869 | 0.659 | 0.495 | 0.436 | 0.471 | 0.531 | 0.520 | 0.520 | 0.520 |  |
| 342.0    | 1.150            | 0.954 | 0.738 | 0.563 | 0.489 | 0.491 | 0.522 | 0.519 | 0.521 | 0.524 |  |
| 346.5    | 1.132            | 0.936 | 0.705 | 0.550 | 0.468 | 0.484 | 0.509 | 0.512 | 0.514 | 0.534 |  |
| 351.0    | 1.203            | 1.006 | 0.769 | 0.549 | 0.457 | 0.478 | 0.515 | 0.511 | 0.508 | 0.520 |  |
| 355.5    | 1.257            | 1.062 | 0.817 | 0.626 | 0.510 | 0.507 | 0.542 | 0.529 | 0.530 | 0.539 |  |
| AVERAGE  | 1.207            | 1.023 | 0.798 | 0.605 | 0.496 | 0.472 | 0.515 | 0.508 | 0.508 | 0.516 |  |
| MIN.     | 1.007            | 0.833 | 0.612 | 0.492 | 0.411 | 0.384 | 0.402 | 0.434 | 0.443 | 0.469 |  |
| MAX.     | 1.332            | 1.208 | 1.007 | 0.823 | 0.676 | 0.611 | 0.646 | 0.638 | 0.626 | 0.620 |  |
| STD      | 0.092            | 0.099 | 0.096 | 0.075 | 0.054 | 0.044 | 0.039 | 0.034 | 0.031 | 0.027 |  |

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TWR-50170  
 DOC NO. \_\_\_\_\_  
 SEC. \_\_\_\_\_ PAGE \_\_\_\_\_ VOL. \_\_\_\_\_  
 24

ATTACHMENT IV. PSA-2 Thickness Measurements

PSA-2 THICKNESS MEASUREMENTS - DATA SUMMARY - 15 OCTOBER, 1989

| Angular Location | Radial Distance Outward from the Igniter Boss |        |        |        |        |        |        |        |        |        |
|------------------|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                  | 3.5   | 4.0    | 4.5    | 5.0    | 5.5    | 6.0    | 6.5    | 7.0    | 7.5    | 8.0    |
| 4.5              | 1.1970  | 0.8518 | 0.6360 | 0.5584 | 0.5342 | 0.5324 | 0.5361 | 0.5356 | 0.5462 | 0.5432 |
| 9.0              | 1.2296  | 0.8829 | 0.6672 | 0.5638 | 0.5433 | 0.5361 | 0.5386 | 0.5370 | 0.5441 | 0.5414 |
| 13.5             | 1.1683  | 0.9038 | 0.6680 | 0.7510 | 0.5424 | 0.5380 | 0.5427 | 0.5414 | 0.5512 | 0.5481 |
| 18.0             | 1.2739  | 0.9666 | 0.7485 | 0.8036 | 0.5512 | 0.5351 | 0.5343 | 0.5385 | 0.5395 | 0.5454 |
| 22.5             | 1.3562  | 1.0597 | 0.8346 | 0.8811 | 0.5739 | 0.5298 | 0.5193 | 0.5258 | 0.5257 | 0.5337 |
| 27.0             | 1.4484  | 1.1203 | 0.8820 | 0.8840 | 0.5804 | 0.5400 | 0.5280 | 0.5284 | 0.5319 | 0.5290 |
| 31.5             | 1.4534  | 1.1281 | 0.8513 | 0.8704 | 0.5782 | 0.5435 | 0.5395 | 0.5477 | 0.5569 | 0.5569 |
| 36.0             | 1.3095  | 1.0280 | 0.8141 | 0.8417 | 0.5805 | 0.5840 | 0.5846 | 0.5734 | 0.5844 | 0.5827 |
| 40.5             | 1.2108  | 0.9354 | 0.7084 | 0.5784 | 0.5317 | 0.5241 | 0.5256 | 0.5298 | 0.5374 | 0.5384 |
| 45.0             | 1.1957  | 0.8986 | 0.6678 | 0.5696 | 0.5219 | 0.5149 | 0.5186 | 0.5236 | 0.5313 | 0.5320 |
| 49.5             | 1.2203  | 0.9249 | 0.6878 | 0.5638 | 0.5248 | 0.5170 | 0.5184 | 0.5249 | 0.5305 | 0.5316 |
| 54.0             | 1.2878  | 0.9658 | 0.7570 | 0.6072 | 0.5522 | 0.5339 | 0.5332 | 0.5358 | 0.5422 | 0.5412 |
| 58.5             | 1.3570  | 1.0783 | 0.8554 | 0.6995 | 0.6338 | 0.6086 | 0.6090 | 0.6155 | 0.6194 | 0.6235 |
| 63.0             | 1.3130  | 1.0094 | 0.7723 | 0.6284 | 0.5611 | 0.5427 | 0.5479 | 0.5475 | 0.5526 | 0.5471 |
| 67.5             | 1.2012  | 0.9032 | 0.6588 | 0.5438 | 0.5136 | 0.5130 | 0.5197 | 0.5234 | 0.5311 | 0.5325 |
| 72.0             | 1.3318  | 1.0042 | 0.7693 | 0.6152 | 0.5423 | 0.5236 | 0.5288 | 0.5350 | 0.5339 | 0.5349 |
| 76.5             | 1.3116  | 0.9973 | 0.7511 | 0.5912 | 0.5296 | 0.5147 | 0.5196 | 0.5228 | 0.5328 | 0.5333 |
| 81.0             | 1.3353  | 1.0232 | 0.7786 | 0.5982 | 0.5409 | 0.5237 | 0.5257 | 0.5301 | 0.5363 | 0.5415 |
| 85.5             | 1.2628  | 0.9561 | 0.7268 | 0.5392 | 0.5437 | 0.5278 | 0.5247 | 0.5276 | 0.5309 | 0.5307 |
| 90.0             | 1.2151  | 0.9005 | 0.6907 | 0.5792 | 0.5318 | 0.5309 | 0.5302 | 0.5384 | 0.5389 | 0.5411 |
| 94.5             | 1.2952  | 0.9888 | 0.7297 | 0.6097 | 0.5732 | 0.5680 | 0.5707 | 0.5751 | 0.5777 | 0.5757 |
| 99.0             | 1.3954  | 1.0685 | 0.8374 | 0.6616 | 0.5889 | 0.5644 | 0.5647 | 0.5722 | 0.5787 | 0.5804 |
| 103.5            | 1.4776  | 1.1772 | 0.8987 | 0.7340 | 0.6493 | 0.6163 | 0.6136 | 0.6201 | 0.6255 | 0.6303 |
| 108.0            | 1.4843  | 1.1481 | 0.8965 | 0.7378 | 0.6186 | 0.5583 | 0.5419 | 0.5463 | 0.5508 | 0.5767 |
| 112.5            | 1.6122  | 1.2345 | 0.9640 | 0.7284 | 0.6015 | 0.5379 | 0.5228 | 0.5218 | 0.5259 | 0.5258 |
| 117.0            | 1.4042  | 1.0229 | 0.7599 | 0.5848 | 0.5268 | 0.5124 | 0.5178 | 0.5281 | 0.5244 | 0.5296 |
| 121.5            | 1.3755  | 1.0181 | 0.7814 | 0.6312 | 0.5551 | 0.5343 | 0.5333 | 0.5345 | 0.5343 | 0.5387 |
| 126.0            | 1.2829  | 0.9193 | 0.6924 | 0.5815 | 0.5392 | 0.5355 | 0.5293 | 0.5359 | 0.5371 | 0.5382 |
| 130.5            | 1.2565  | 0.9145 | 0.6654 | 0.5883 | 0.5358 | 0.5278 | 0.5298 | 0.5381 | 0.5379 | 0.5384 |
| 135.0            | 1.2391  | 0.9011 | 0.6804 | 0.5650 | 0.5317 | 0.5288 | 0.5293 | 0.5405 | 0.5411 | 0.5407 |
| 139.5            | 1.2276  | 0.9088 | 0.6964 | 0.5712 | 0.5336 | 0.5320 | 0.5328 | 0.5405 | 0.5400 | 0.5395 |
| 144.0            | 1.2787  | 0.9343 | 0.7200 | 0.5873 | 0.5442 | 0.5310 | 0.5309 | 0.5362 | 0.5376 | 0.5412 |
| 148.5            | 1.3724  | 1.0471 | 0.8021 | 0.6559 | 0.5871 | 0.5587 | 0.5549 | 0.5688 | 0.5743 | 0.5732 |
| 153.0            | 1.5076  | 1.1527 | 0.9000 | 0.7521 | 0.6653 | 0.6030 | 0.5846 | 0.5866 | 0.5909 | 0.5929 |
| 157.5            | 1.5824  | 1.2383 | 0.9874 | 0.7908 | 0.6495 | 0.6675 | 0.5355 | 0.5317 | 0.5393 | 0.5371 |
| 162.0            | 1.4811  | 1.1216 | 0.8788 | 0.7066 | 0.5866 | 0.5350 | 0.5224 | 0.5294 | 0.5351 | 0.5406 |
| 166.5            | 1.3940  | 1.0455 | 0.8087 | 0.6407 | 0.5549 | 0.5255 | 0.5178 | 0.5232 | 0.5406 | 0.5421 |
| 171.0            | 1.3599  | 1.0238 | 0.8009 | 0.6282 | 0.5571 | 0.5336 | 0.5324 | 0.5374 | 0.5511 | 0.5484 |
| 175.5            | 1.3116  | 1.0055 | 0.7965 | 0.6480 | 0.6082 | 0.5958 | 0.5977 | 0.5993 | 0.6168 | 0.6156 |
| 180.0            | 1.2870  | 0.9717 | 0.7412 | 0.6308 | 0.5902 | 0.5800 | 0.5797 | 0.5829 | 0.5998 | 0.5991 |
| 184.5            | 1.2281  | 0.9011 | 0.6964 | 0.5780 | 0.5435 | 0.5402 | 0.5384 | 0.5418 | 0.5476 | 0.5443 |
| 189.0            | 1.2694  | 0.9756 | 0.7722 | 0.6265 | 0.5728 | 0.5814 | 0.5595 | 0.5836 | 0.5733 | 0.5706 |
| 193.5            | 1.2693  | 0.9469 | 0.6750 | 0.5847 | 0.5453 | 0.5477 | 0.5465 | 0.5476 | 0.5537 | 0.5503 |
| 198.0            | 1.0641  | 0.7577 | 0.5825 | 0.5340 | 0.5265 | 0.5280 | 0.5302 | 0.5374 | 0.5359 | 0.5353 |
| 202.5            | 0.9730  | 0.7040 | 0.5437 | 0.5287 | 0.5268 | 0.5299 | 0.5282 | 0.5330 | 0.5381 | 0.5349 |
| 207.0            | 1.0721  | 0.7949 | 0.6083 | 0.5392 | 0.5278 | 0.5297 | 0.5288 | 0.5355 | 0.5377 | 0.5368 |
| 211.5            | 1.0749  | 0.8059 | 0.6124 | 0.5415 | 0.5310 | 0.5272 | 0.5285 | 0.5368 | 0.5853 | 0.5368 |
| 216.0            | 1.1310  | 0.8595 | 0.6366 | 0.5588 | 0.5300 | 0.5285 | 0.5280 | 0.5366 | 0.5357 | 0.5334 |
| 220.5            | 1.0819  | 0.7673 | 0.6387 | 0.5501 | 0.5317 | 0.5296 | 0.5305 | 0.5402 | 0.5389 | 0.5382 |
| 225.0            | 1.0791  | 0.7718 | 0.6038 | 0.5407 | 0.5309 | 0.5329 | 0.5342 | 0.5428 | 0.5411 | 0.5401 |

ATTACHMENT IV. PSA-2 Thickness Measurements (Continued)

Angular Location      Radial Distance Outward From The Igniter Boss

|         |        |        |        |        |        |        |        |        |        |        |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 229.5   | 1.0132 | 0.7395 | 0.5899 | 0.5374 | 0.5322 | 0.5335 | 0.5358 | 0.5441 | 0.5418 | 0.5405 |
| 234.0   | 0.9856 | 0.7404 | 0.5939 | 0.5383 | 0.5297 | 0.5324 | 0.5359 | 0.5437 | 0.5417 | 0.5384 |
| 238.5   | 1.1278 | 0.8107 | 0.6547 | 0.5596 | 0.5401 | 0.5414 | 0.5425 | 0.5429 | 0.5525 | 0.5476 |
| 243.0   | 1.2055 | 0.8812 | 0.7245 | 0.6256 | 0.6959 | 0.5995 | 0.5945 | 0.5959 | 0.6112 | 0.8124 |
| 247.5   | 1.3343 | 1.0381 | 0.7978 | 0.6506 | 0.5774 | 0.5555 | 0.5584 | 0.5582 | 0.5655 | 0.5626 |
| 252.0   | 1.3238 | 1.0397 | 0.8046 | 0.6150 | 0.5819 | 0.5506 | 0.5592 | 0.5582 | 0.5841 | 0.5890 |
| 256.5   | 1.4028 | 1.0320 | 0.7727 | 0.8099 | 0.5395 | 0.5235 | 0.5193 | 0.5247 | 0.5338 | 0.5375 |
| 261.0   | 1.3557 | 1.0473 | 0.8097 | 0.8307 | 0.5543 | 0.5282 | 0.5250 | 0.5294 | 0.5337 | 0.5355 |
| 265.5   | 1.2352 | 0.9263 | 0.7007 | 0.5847 | 0.5341 | 0.5230 | 0.5209 | 0.5272 | 0.5447 | 0.5430 |
| 270.0   | 1.1412 | 0.8295 | 0.6319 | 0.5525 | 0.5284 | 0.5233 | 0.5240 | 0.5343 | 0.5470 | 0.5409 |
| 274.5   | 1.1340 | 0.7926 | 0.6253 | 0.5555 | 0.5362 | 0.5345 | 0.5446 | 0.5392 | 0.5471 | 0.5426 |
| 279.0   | 1.0925 | 0.7813 | 0.6217 | 0.5528 | 0.5297 | 0.5341 | 0.5368 | 0.5439 | 0.5507 | 0.5462 |
| 283.5   | 1.1245 | 0.8249 | 0.6478 | 0.5707 | 0.5495 | 0.5488 | 0.5499 | 0.5522 | 0.5579 | 0.5610 |
| 288.0   | 1.2880 | 0.9539 | 0.7180 | 0.6019 | 0.5490 | 0.5382 | 0.5355 | 0.5456 | 0.5482 | 0.5471 |
| 292.5   | 1.1776 | 0.8340 | 0.6327 | 0.5498 | 0.5317 | 0.5288 | 0.5318 | 0.5370 | 0.5357 | 0.5367 |
| 297.0   | 1.0405 | 0.7118 | 0.5479 | 0.5203 | 0.5182 | 0.5272 | 0.5298 | 0.5327 | 0.5367 | 0.5350 |
| 301.5   | 1.0628 | 0.7422 | 0.5691 | 0.5222 | 0.5139 | 0.5195 | 0.5238 | 0.5295 | 0.5309 | 0.5312 |
| 306.0   | 1.3272 | 0.9838 | 0.7449 | 0.5938 | 0.5378 | 0.5225 | 0.5205 | 0.5264 | 0.5271 | 0.5323 |
| 310.5   | 1.3182 | 1.0075 | 0.7776 | 0.6328 | 0.5555 | 0.5268 | 0.5193 | 0.5312 | 0.5287 | 0.5335 |
| 315.0   | 1.3251 | 0.9520 | 0.7185 | 0.5909 | 0.5350 | 0.5186 | 0.5183 | 0.5264 | 0.5303 | 0.5332 |
| 319.5   | 1.2394 | 0.9314 | 0.6841 | 0.5823 | 0.5455 | 0.5433 | 0.5491 | 0.5816 | 0.5812 | 0.5816 |
| 324.0   | 1.2004 | 0.8855 | 0.7033 | 0.6305 | 0.6074 | 0.6086 | 0.6073 | 0.6164 | 0.6202 | 0.6259 |
| 328.5   | 1.1706 | 0.8789 | 0.6753 | 0.5815 | 0.5588 | 0.5545 | 0.5555 | 0.5802 | 0.5802 | 0.5804 |
| 333.0   | 1.2728 | 0.8585 | 0.7484 | 0.6945 | 0.6128 | 0.6031 | 0.6000 | 0.6087 | 0.6081 | 0.6154 |
| 337.5   | 1.3005 | 0.9707 | 0.7887 | 0.6251 | 0.5658 | 0.5549 | 0.5631 | 0.5670 | 0.5665 | 0.5628 |
| 342.0   | 1.2288 | 0.9297 | 0.6862 | 0.5682 | 0.5304 | 0.5270 | 0.5295 | 0.5351 | 0.5340 | 0.5351 |
| 346.5   | 1.1713 | 0.8684 | 0.6488 | 0.5449 | 0.5213 | 0.5251 | 0.5300 | 0.5307 | 0.5353 | 0.5328 |
| 351.0   | 1.1414 | 0.8302 | 0.6211 | 0.5395 | 0.5238 | 0.5280 | 0.5297 | 0.5335 | 0.5350 | 0.5359 |
| 355.5   | 1.2284 | 0.9284 | 0.7241 | 0.5991 | 0.5501 | 0.5367 | 0.5388 | 0.5445 | 0.5413 | 0.5384 |
| 360.0   | 1.2045 | 0.8886 | 0.6758 | 0.5728 | 0.5408 | 0.5343 | 0.5330 | 0.5341 | 0.5430 | 0.5424 |
| Average | 1.259  | 0.943  | 0.724  | 0.605  | 0.556  | 0.543  | 0.541  | 0.546  | 0.551  | 0.551  |
| S.D.    | 0.131  | 0.118  | 0.094  | 0.059  | 0.036  | 0.027  | 0.023  | 0.023  | 0.025  | 0.025  |
| Maximum | 1.812  | 1.238  | 0.987  | 0.791  | 0.696  | 0.668  | 0.614  | 0.620  | 0.626  | 0.630  |
| Minimum | 0.973  | 0.704  | 0.544  | 0.520  | 0.514  | 0.512  | 0.518  | 0.522  | 0.524  | 0.528  |

TWR-50170

REVISION \_\_\_\_\_

| DOC NO. | VOL     |
|---------|---------|
| SEC     | PAGE 26 |

ATTACHMENT V. PSA-3 Thickness Measurements

PSA-3 THICKNESS MEASUREMENTS - DATA SUMMARY - 20 OCTOBER, 1989

| Angular<br>Location | Radial Distance Outward from the Igniter Boss |        |        |        |        |        |        |        |        |        |        |
|---------------------|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                     | 3.0   | 3.5    | 4.0    | 4.5    | 5.0    | 5.5    | 6.0    | 6.5    | 7.0    | 7.5    | 8.0    |
| 0.0                 | 1.3805  | 0.9478 | 0.7120 | 0.5918 | 0.5261 | 0.5101 | 0.5428 | 0.5502 | 0.5363 | 0.5353 | 0.5361 |
|                     | 1.4657  | 1.0038 | 0.7768 | 0.6477 | 0.5259 | 0.5063 | 0.5566 | 0.5743 | 0.5608 | 0.5313 | 0.5325 |
|                     | 1.4763  | 1.0684 | 0.7922 | 0.6266 | 0.5577 | 0.5161 | 0.5493 | 0.5638 | 0.5493 | 0.5295 | 0.5341 |
|                     | 1.5105  | 0.9690 | 0.7567 | 0.6226 | 0.5297 | 0.5035 | 0.5357 | 0.5401 | 0.5331 | 0.5313 | 0.5330 |
|                     | 1.4023  | 1.0516 | 0.7608 | 0.5920 | 0.5413 | 0.5209 | 0.5321 | 0.5478 | 0.5547 | 0.5304 | 0.5279 |
|                     | 1.3931  | 0.9787 | 0.7198 | 0.5924 | 0.5347 | 0.5158 | 0.5339 | 0.5544 | 0.5483 | 0.5401 | 0.5314 |
|                     | 1.3931  | 0.9574 | 0.6960 | 0.5827 | 0.5307 | 0.5130 | 0.5361 | 0.5635 | 0.5433 | 0.5428 | 0.5345 |
|                     | 1.4983  | 0.9880 | 0.7455 | 0.6335 | 0.5619 | 0.5319 | 0.5439 | 0.5549 | 0.5681 | 0.5460 | 0.5379 |
|                     | 1.4878  | 1.0384 | 0.7868 | 0.6544 | 0.5722 | 0.5491 | 0.5418 | 0.5721 | 0.5700 | 0.5543 | 0.5472 |
|                     | 1.4820  | 0.9675 | 0.7316 | 0.6272 | 0.5693 | 0.5296 | 0.5477 | 0.5645 | 0.5499 | 0.5376 | 0.5292 |
| 45.0                | 1.4059  | 0.9870 | 0.7464 | 0.6088 | 0.5496 | 0.5120 | 0.5176 | 0.5603 | 0.5506 | 0.5351 | 0.5280 |
|                     | 1.4070  | 0.9603 | 0.7479 | 0.6243 | 0.5626 | 0.5171 | 0.5201 | 0.5680 | 0.5569 | 0.5421 | 0.5342 |
|                     | 1.4287  | 0.9824 | 0.7332 | 0.6127 | 0.5396 | 0.5168 | 0.5167 | 0.5485 | 0.5435 | 0.5355 | 0.5316 |
|                     | 1.4273  | 0.9552 | 0.6786 | 0.5731 | 0.5368 | 0.5241 | 0.5209 | 0.5440 | 0.5394 | 0.5348 | 0.5303 |
|                     | 1.3800  | 0.9536 | 0.6811 | 0.5711 | 0.5261 | 0.5134 | 0.5295 | 0.5473 | 0.5390 | 0.5330 | 0.5359 |
|                     | 1.4695  | 0.9708 | 0.6973 | 0.5851 | 0.5318 | 0.5073 | 0.5103 | 0.5472 | 0.5361 | 0.5307 | 0.5353 |
|                     | 1.5158  | 1.0309 | 0.7780 | 0.6258 | 0.5555 | 0.5153 | 0.5107 | 0.5463 | 0.5531 | 0.5356 | 0.5344 |
|                     | 1.4815  | 1.0474 | 0.7761 | 0.6164 | 0.5509 | 0.5090 | 0.5052 | 0.5358 | 0.5491 | 0.5407 | 0.5367 |
|                     | 1.4477  | 0.9978 | 0.7495 | 0.6150 | 0.5480 | 0.5112 | 0.5149 | 0.5500 | 0.5505 | 0.5365 | 0.5310 |
|                     | 1.5784  | 1.0462 | 0.7763 | 0.6451 | 0.5614 | 0.5139 | 0.5062 | 0.5435 | 0.5552 | 0.5349 | 0.5304 |
| 90.0                | 1.4578  | 1.0345 | 0.7630 | 0.6393 | 0.5653 | 0.5226 | 0.5239 | 0.5786 | 0.5522 | 0.5346 | 0.5295 |
|                     | 1.4980  | 1.0330 | 0.7635 | 0.6407 | 0.5652 | 0.5372 | 0.5449 | 0.6049 | 0.5740 | 0.5339 | 0.5272 |
|                     | 1.4736  | 0.9757 | 0.6726 | 0.5839 | 0.5405 | 0.5482 | 0.5333 | 0.5643 | 0.5516 | 0.5311 | 0.5258 |
|                     | 1.3718  | 0.9279 | 0.6786 | 0.5829 | 0.5272 | 0.4994 | 0.5082 | 0.5435 | 0.5375 | 0.5332 | 0.5305 |
|                     | 1.4005  | 0.9012 | 0.6759 | 0.5832 | 0.5301 | 0.5170 | 0.5145 | 0.5560 | 0.5451 | 0.5341 | 0.5332 |
|                     | 1.3639  | 0.9042 | 0.6690 | 0.5749 | 0.5370 | 0.5207 | 0.5206 | 0.5559 | 0.5386 | 0.5322 | 0.5335 |
|                     | 1.4490  | 0.9111 | 0.6844 | 0.5780 | 0.5243 | 0.5114 | 0.5141 | 0.5705 | 0.5470 | 0.5433 | 0.5368 |
|                     | 1.5020  | 0.9484 | 0.6845 | 0.5921 | 0.5308 | 0.5137 | 0.5107 | 0.5548 | 0.5468 | 0.5394 | 0.5390 |
|                     | 1.4618  | 0.9670 | 0.7118 | 0.5959 | 0.5383 | 0.5205 | 0.5148 | 0.5544 | 0.5509 | 0.5413 | 0.5359 |
|                     | 1.5591  | 0.9299 | 0.7109 | 0.5869 | 0.5557 | 0.5334 | 0.5251 | 0.5491 | 0.5548 | 0.5379 | 0.5347 |
|                     | 1.5765  | 1.0109 | 0.7314 | 0.6010 | 0.5484 | 0.5280 | 0.5202 | 0.5445 | 0.5536 | 0.5430 | 0.5366 |
| 135.0               | 1.3699  | 0.8693 | 0.6569 | 0.5706 | 0.5313 | 0.5220 | 0.5274 | 0.5706 | 0.5493 | 0.5383 | 0.5359 |
|                     | 1.3020  | 0.8419 | 0.6466 | 0.5555 | 0.5201 | 0.5172 | 0.5214 | 0.5636 | 0.5516 | 0.5380 | 0.5359 |
|                     | 1.2910  | 0.8224 | 0.6394 | 0.5578 | 0.5283 | 0.5230 | 0.5283 | 0.5607 | 0.5395 | 0.5298 | 0.5336 |
|                     | 1.3625  | 0.8451 | 0.6645 | 0.5847 | 0.5425 | 0.5345 | 0.5404 | 0.5626 | 0.5472 | 0.5384 | 0.5397 |
|                     | 1.4597  | 0.9197 | 0.7024 | 0.5938 | 0.5501 | 0.5410 | 0.5494 | 0.5847 | 0.5663 | 0.5605 | 0.5450 |
|                     | 1.5012  | 0.8735 | 0.6632 | 0.5745 | 0.5345 | 0.5257 | 0.5390 | 0.5814 | 0.5813 | 0.5381 | 0.5358 |
|                     | 1.4175  | 0.8841 | 0.6658 | 0.5836 | 0.5362 | 0.5296 | 0.5444 | 0.5713 | 0.5559 | 0.5392 | 0.5384 |
|                     | 1.5388  | 0.9032 | 0.6765 | 0.5909 | 0.5355 | 0.5265 | 0.5291 | 0.5573 | 0.5461 | 0.5364 | 0.5345 |
|                     | 1.4372  | 0.8981 | 0.6837 | 0.5924 | 0.5452 | 0.5311 | 0.5278 | 0.5593 | 0.5456 | 0.5404 | 0.5391 |
| 180.0               | 1.3595  | 0.8320 | 0.6480 | 0.5697 | 0.5420 | 0.5261 | 0.5384 | 0.5704 | 0.5428 | 0.5359 | 0.5371 |
|                     | 1.4095  | 0.8902 | 0.6712 | 0.5709 | 0.5406 | 0.5257 | 0.5193 | 0.5768 | 0.5464 | 0.5347 | 0.5342 |
|                     | 1.4677  | 0.9016 | 0.6922 | 0.5754 | 0.5349 | 0.5308 | 0.5262 | 0.5568 | 0.5325 | 0.5312 | 0.5321 |
|                     | 1.4957  | 0.9451 | 0.6989 | 0.5919 | 0.5450 | 0.5339 | 0.5273 | 0.5676 | 0.5373 | 0.5366 | 0.5329 |
|                     | 1.4314  | 0.9355 | 0.7102 | 0.5933 | 0.5414 | 0.5253 | 0.5184 | 0.5621 | 0.5410 | 0.5324 | 0.5297 |
|                     | 1.5330  | 1.0170 | 0.7471 | 0.6212 | 0.5592 | 0.5294 | 0.5150 | 0.5505 | 0.5524 | 0.5362 | 0.5293 |
|                     | 1.3051  | 0.8805 | 0.6756 | 0.6031 | 0.5550 | 0.5253 | 0.5200 | 0.5591 | 0.5441 | 0.5362 | 0.5327 |
|                     | 1.4701  | 0.8959 | 0.7052 | 0.6145 | 0.5595 | 0.5222 | 0.5139 | 0.5574 | 0.5426 | 0.5411 | 0.5343 |
|                     | 1.4974  | 0.9084 | 0.6895 | 0.6052 | 0.5579 | 0.5297 | 0.5216 | 0.5688 | 0.5668 | 0.5339 |        |

TWR-50170

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|---------|------|
| DOC NO. | VOL  |
| SEC     | PAGE |
|         | 27   |

ATTACHMENT V. PSA-3 Thickness Measurements (Continued)

PSA-3 THICKNESS MEASUREMENTS - DATA SUMMARY - 20 OCTOBER, 1989

| Angular Radial Distance Outward from the Igniter Boss |         |        |        |        |        |        |        |        |        |        |        |       |
|---|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|
| Location  | 3.0     | 3.5    | 4.0    | 4.5    | 5.0    | 5.5    | 6.0    | 6.5    | 7.0    | 7.5    | 8.0    |       |
| 225.0   | 1.5241  | 0.8939 | 0.6835 | 0.5455 | 0.5277 | 0.5151 | 0.5195 | 0.5644 | 0.5483 | 0.5345 | 0.5305 |       |
|   | 1.4612  | 0.8509 | 0.6619 | 0.5793 | 0.5363 | 0.5091 | 0.5140 | 0.5612 | 0.5441 | 0.5270 | 0.5229 |       |
|   | 1.4232  | 0.9361 | 0.7170 | 0.5891 | 0.5254 | 0.5034 | 0.5162 | 0.5557 | 0.5474 | 0.5337 | 0.5268 |       |
|   | 1.4498  | 0.9587 | 0.7364 | 0.5990 | 0.5394 | 0.5254 | 0.5163 | 0.5279 | 0.5435 | 0.5372 | 0.5267 |       |
|   | 1.4422  | 0.9780 | 0.7428 | 0.5953 | 0.5432 | 0.5322 | 0.5421 | 0.5555 | 0.5477 | 0.5299 | 0.5207 |       |
|   | 1.4614  | 0.9932 | 0.7672 | 0.6177 | 0.5432 | 0.5228 | 0.5402 | 0.5688 | 0.5561 | 0.5381 | 0.5334 |       |
|   | 1.6020  | 1.0849 | 0.7999 | 0.6579 | 0.5924 | 0.5570 | 0.5400 | 0.5820 | 0.5856 | 0.5691 | 0.5612 |       |
|   | 1.3728  | 0.9326 | 0.7242 | 0.6299 | 0.5074 | 0.5425 | 0.5424 | 0.6007 | 0.5745 | 0.5507 | 0.5478 |       |
|   | 1.4147  | 0.9578 | 0.7326 | 0.6150 | 0.5588 | 0.5280 | 0.5197 | 0.5714 | 0.5514 | 0.5377 | 0.5359 |       |
|   | 1.3228  | 0.9449 | 0.7256 | 0.6061 | 0.5461 | 0.5272 | 0.5234 | 0.5693 | 0.5459 | 0.5334 | 0.5334 |       |
| 270.0   | 1.3732  | 0.9648 | 0.7359 | 0.6003 | 0.5568 | 0.5197 | 0.5232 | 0.5648 | 0.5510 | 0.5377 | 0.5337 |       |
|   | 1.1957  | 0.9073 | 0.7080 | 0.5764 | 0.5371 | 0.5300 | 0.5397 | 0.5714 | 0.5423 | 0.5341 | 0.5396 |       |
|   | 1.3386  | 0.8909 | 0.6843 | 0.5751 | 0.5392 | 0.5193 | 0.5573 | 0.5665 | 0.5455 | 0.5333 | 0.5314 |       |
|   | 1.1358  | 0.8309 | 0.6468 | 0.5531 | 0.5484 | 0.5436 | 0.5586 | 0.5507 | 0.5454 | 0.5291 | 0.5285 |       |
|   | 1.2406  | 0.8714 | 0.6542 | 0.5603 | 0.5455 | 0.5289 | 0.5482 | 0.5524 | 0.5460 | 0.5334 | 0.5333 |       |
|   | 1.3277  | 0.8611 | 0.6498 | 0.5563 | 0.5357 | 0.5306 | 0.5481 | 0.5606 | 0.5516 | 0.5340 | 0.5330 |       |
|   | 1.3099  | 0.9026 | 0.6478 | 0.5533 | 0.5258 | 0.5181 | 0.5374 | 0.5599 | 0.5421 | 0.5329 | 0.5284 |       |
|   | 1.4156  | 0.9846 | 0.7175 | 0.5920 | 0.5360 | 0.5106 | 0.5292 | 0.5493 | 0.5503 | 0.5386 | 0.5312 |       |
|   | 1.2643  | 0.8753 | 0.6643 | 0.5673 | 0.5269 | 0.5149 | 0.5389 | 0.5382 | 0.5486 | 0.5382 | 0.5313 |       |
|   | 1.2866  | 0.9130 | 0.6840 | 0.5969 | 0.5406 | 0.5137 | 0.5475 | 0.5359 | 0.5407 | 0.5420 | 0.5305 |       |
| 315.0   | 1.3226  | 0.8966 | 0.6955 | 0.5950 | 0.5347 | 0.5312 | 0.5754 | 0.5686 | 0.5755 | 0.5469 | 0.5363 |       |
|   | 1.2684  | 0.9218 | 0.6815 | 0.5912 | 0.5380 | 0.5219 | 0.5382 | 0.5372 | 0.5472 | 0.5377 | 0.5314 |       |
|   | 1.2484  | 0.9076 | 0.6702 | 0.5706 | 0.5282 | 0.5168 | 0.5673 | 0.5435 | 0.5400 | 0.5421 | 0.5345 |       |
|   | 1.2596  | 0.9163 | 0.6670 | 0.5784 | 0.5304 | 0.5109 | 0.5539 | 0.5386 | 0.5473 | 0.5385 | 0.5473 |       |
|   | 1.2768  | 0.9109 | 0.6662 | 0.5630 | 0.5259 | 0.5126 | 0.5426 | 0.5378 | 0.5383 | 0.5403 | 0.5388 |       |
|   | 1.2838  | 0.9243 | 0.6819 | 0.5902 | 0.5377 | 0.5153 | 0.5335 | 0.5391 | 0.5357 | 0.5336 | 0.5300 |       |
|   | 1.3033  | 0.9346 | 0.6908 | 0.5992 | 0.5432 | 0.5210 | 0.5481 | 0.5487 | 0.5359 | 0.5336 | 0.5414 |       |
|   | 1.3108  | 0.9154 | 0.6942 | 0.5988 | 0.5389 | 0.5134 | 0.5358 | 0.5434 | 0.5371 | 0.5290 | 0.5360 |       |
|   | 1.3349  | 0.9357 | 0.7140 | 0.5939 | 0.5486 | 0.5230 | 0.5291 | 0.5566 | 0.5423 | 0.5322 | 0.5365 |       |
|   | 1.3194  | 0.9561 | 0.6764 | 0.5911 | 0.5300 | 0.5143 | 0.5461 | 0.5588 | 0.5418 | 0.5347 | 0.5349 |       |
| 355.0   | 1.3221  | 0.8886 | 0.6618 | 0.5763 | 0.5276 | 0.5194 | 0.5439 | 0.5519 | 0.5415 | 0.5376 | 0.5341 |       |
|   | Average | 1.405  | 0.939  | 0.705  | 0.595  | 0.542  | 0.522  | 0.532  | 0.558  | 0.549  | 0.537  | 0.534 |
|   | S.D.    | 0.094  | 0.058  | 0.040  | 0.025  | 0.014  | 0.011  | 0.015  | 0.014  | 0.011  | 0.007  | 0.006 |
|   | Maximum | 1.602  | 1.085  | 0.800  | 0.658  | 0.592  | 0.557  | 0.575  | 0.605  | 0.586  | 0.569  | 0.561 |
|   | Minimum | 1.136  | 0.822  | 0.639  | 0.546  | 0.507  | 0.499  | 0.505  | 0.528  | 0.533  | 0.524  | 0.521 |

TWR-50170

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DOC NO. SEC PAGE VOL

28

ATTACHMENT VI. PSA-4 Thickness Measurements

PSA-4 THICKNESS MEASUREMENTS - DATA SUMMARY - 24 OCTOBER, 1989

| Angular  | Radial Distance Outward from the Igniter Boss |        |        |        |        |        |        |        |        |        |
|----------|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Location | 3.5   | 4.0    | 4.5    | 5.0    | 5.5    | 6.0    | 6.5    | 7.0    | 7.5    | 8.0    |
| 5.0      | 1.1462  | 0.8049 | 0.6686 | 0.5940 | 0.5738 | 0.5761 | 0.5816 | 0.5828 | 0.5817 | 0.5834 |
| 10.0     | 1.0446  | 0.7655 | 0.6107 | 0.5738 | 0.5703 | 0.5777 | 0.5807 | 0.5865 | 0.5880 | 0.5900 |
| 15.0     | 1.0951  | 0.7919 | 0.6312 | 0.5795 | 0.5721 | 0.5734 | 0.5782 | 0.5859 | 0.5884 | 0.5888 |
| 20.0     | 1.1588  | 0.8099 | 0.6421 | 0.5803 | 0.5683 | 0.5706 | 0.5774 | 0.5874 | 0.5864 | 0.5871 |
| 25.0     | 1.0815  | 0.7819 | 0.6278 | 0.5763 | 0.5659 | 0.5682 | 0.5704 | 0.5830 | 0.5817 | 0.5832 |
| 30.0     | 1.0108  | 0.7143 | 0.5699 | 0.5393 | 0.5391 | 0.5472 | 0.5535 | 0.5571 | 0.5533 | 0.5520 |
| 35.0     | 1.0524  | 0.7312 | 0.5741 | 0.5395 | 0.5410 | 0.5453 | 0.5457 | 0.5457 | 0.5455 | 0.5447 |
| 40.0     | 1.1376  | 0.8165 | 0.6354 | 0.5824 | 0.5719 | 0.5757 | 0.5822 | 0.5849 | 0.5852 | 0.5862 |
| 45.0     | 1.1117  | 0.8142 | 0.6548 | 0.5974 | 0.5840 | 0.5821 | 0.5807 | 0.5878 | 0.5910 | 0.5889 |
| 50.0     | 1.1045  | 0.7950 | 0.6318 | 0.5776 | 0.5709 | 0.5740 | 0.5751 | 0.5850 | 0.5869 | 0.5874 |
| 55.0     | 1.1070  | 0.8167 | 0.6398 | 0.5709 | 0.5889 | 0.5761 | 0.5765 | 0.5855 | 0.5847 | 0.5863 |
| 60.0     | 1.1155  | 0.7891 | 0.6368 | 0.5819 | 0.5715 | 0.5729 | 0.5741 | 0.5838 | 0.5848 | 0.5851 |
| 65.0     | 1.0872  | 0.7797 | 0.6198 | 0.5754 | 0.5689 | 0.5705 | 0.5726 | 0.5836 | 0.5830 | 0.5853 |
| 70.0     | 1.0503  | 0.7641 | 0.6100 | 0.5730 | 0.5733 | 0.5771 | 0.5801 | 0.5855 | 0.5871 | 0.5877 |
| 75.0     | 1.0223  | 0.7439 | 0.6072 | 0.5718 | 0.5690 | 0.5718 | 0.5731 | 0.5809 | 0.5849 | 0.5851 |
| 80.0     | 0.9569  | 0.7089 | 0.5677 | 0.5472 | 0.5501 | 0.5530 | 0.5600 | 0.5614 | 0.5594 | 0.5612 |
| 85.0     | 0.9888  | 0.7085 | 0.5861 | 0.5500 | 0.5557 | 0.5603 | 0.5698 | 0.5698 | 0.5697 | 0.5706 |
| 90.0     | 1.1874  | 0.8297 | 0.6476 | 0.5855 | 0.5717 | 0.5711 | 0.5786 | 0.5834 | 0.5861 | 0.5877 |
| 95.0     | 1.2007  | 0.8531 | 0.6732 | 0.5960 | 0.5755 | 0.5742 | 0.5815 | 0.5852 | 0.5864 | 0.5892 |
| 100.0    | 1.0475  | 0.7476 | 0.6067 | 0.5755 | 0.5676 | 0.5714 | 0.5774 | 0.5843 | 0.5864 | 0.5868 |
| 105.0    | 1.1336  | 0.7851 | 0.6318 | 0.5757 | 0.5662 | 0.5675 | 0.5712 | 0.5819 | 0.5830 | 0.5849 |
| 110.0    | 1.1001  | 0.7751 | 0.6243 | 0.5816 | 0.5722 | 0.5743 | 0.5778 | 0.5872 | 0.5880 | 0.5934 |
| 115.0    | 1.0178  | 0.7395 | 0.6154 | 0.5753 | 0.5722 | 0.5766 | 0.5792 | 0.5855 | 0.5857 | 0.5874 |
| 120.0    | 0.9188  | 0.6812 | 0.5699 | 0.5537 | 0.5589 | 0.5651 | 0.5738 | 0.5778 | 0.5793 | 0.5837 |
| 125.0    | 0.9803  | 0.6895 | 0.5692 | 0.5503 | 0.5580 | 0.5609 | 0.5679 | 0.5698 | 0.5803 | 0.5792 |
| 130.0    | 1.0762  | 0.7392 | 0.5998 | 0.5651 | 0.5577 | 0.5611 | 0.5682 | 0.5722 | 0.5766 | 0.5793 |
| 135.0    | 1.1063  | 0.7570 | 0.6038 | 0.5629 | 0.5607 | 0.5652 | 0.5718 | 0.5749 | 0.5770 | 0.5764 |
| 140.0    | 1.1007  | 0.7379 | 0.6020 | 0.5628 | 0.5611 | 0.5629 | 0.5786 | 0.5771 | 0.5800 | 0.5855 |
| 145.0    | 1.1276  | 0.7893 | 0.6380 | 0.5850 | 0.5767 | 0.5777 | 0.5788 | 0.5864 | 0.5863 | 0.5900 |
| 150.0    | 1.0139  | 0.7178 | 0.5942 | 0.5630 | 0.5601 | 0.5638 | 0.5747 | 0.5767 | 0.5762 | 0.5768 |
| 155.0    | 1.0376  | 0.7276 | 0.5872 | 0.5519 | 0.5497 | 0.5515 | 0.5623 | 0.5642 | 0.5649 | 0.5669 |
| 160.0    | 1.0210  | 0.7189 | 0.5853 | 0.5559 | 0.5536 | 0.5542 | 0.5667 | 0.5697 | 0.5697 | 0.5721 |
| 165.0    | 1.0298  | 0.7297 | 0.5942 | 0.5629 | 0.5640 | 0.5692 | 0.5787 | 0.5796 | 0.5785 | 0.5781 |
| 170.0    | 0.9690  | 0.6997 | 0.5818 | 0.5572 | 0.5603 | 0.5647 | 0.5680 | 0.5745 | 0.5743 | 0.5747 |
| 175.0    | 1.0430  | 0.6924 | 0.5828 | 0.5605 | 0.5605 | 0.5667 | 0.5723 | 0.5781 | 0.5770 | 0.5754 |
| 180.0    | 1.0509  | 0.7401 | 0.6068 | 0.5715 | 0.5641 | 0.5713 | 0.5731 | 0.5817 | 0.5798 | 0.5791 |
| 185.0    | 1.0721  | 0.7336 | 0.6097 | 0.5686 | 0.5741 | 0.5722 | 0.5748 | 0.5866 | 0.5807 | 0.5822 |
| 190.0    | 1.0711  | 0.7502 | 0.6224 | 0.5716 | 0.5682 | 0.5706 | 0.5758 | 0.5814 | 0.5825 | 0.5841 |
| 195.0    | 1.0978  | 0.7788 | 0.6394 | 0.5795 | 0.5697 | 0.5722 | 0.5751 | 0.5811 | 0.5838 | 0.5901 |
| 200.0    | 1.0604  | 0.7534 | 0.6223 | 0.5693 | 0.5640 | 0.5657 | 0.5708 | 0.5815 | 0.5816 | 0.5800 |
| 205.0    | 1.0718  | 0.7438 | 0.6009 | 0.5534 | 0.5438 | 0.5456 | 0.5471 | 0.5532 | 0.5518 | 0.5526 |
| 210.0    | 1.0303  | 0.7299 | 0.5984 | 0.5666 | 0.5701 | 0.5714 | 0.5752 | 0.5801 | 0.5850 | 0.5848 |
| 215.0    | 1.0155  | 0.7460 | 0.6281 | 0.5760 | 0.5714 | 0.5736 | 0.5760 | 0.5832 | 0.5828 | 0.5893 |
| 220.0    | 0.9818  | 0.7126 | 0.5970 | 0.5590 | 0.5656 | 0.5727 | 0.5878 | 0.5922 | 0.5905 | 0.5947 |
| 225.0    | 1.0448  | 0.7147 | 0.5820 | 0.5594 | 0.5622 | 0.5689 | 0.5691 | 0.5722 | 0.5749 | 0.5762 |
| 230.0    | 1.0574  | 0.7245 | 0.6001 | 0.5572 | 0.5521 | 0.5556 | 0.5578 | 0.5614 | 0.5596 | 0.5629 |
| 235.0    | 1.0241  | 0.7188 | 0.5829 | 0.5489 | 0.5456 | 0.5451 | 0.5514 | 0.5564 | 0.5549 | 0.5536 |
| 240.0    | 0.9669  | 0.6871 | 0.5871 | 0.5624 | 0.5638 | 0.5678 | 0.5753 | 0.5839 | 0.5782 | 0.5819 |
| 245.0    | 0.9423  | 0.6925 | 0.5869 | 0.5666 | 0.5679 | 0.5718 | 0.5794 | 0.5820 | 0.5856 | 0.5861 |

ATTACHMENT VI. PSA-4 Thickness Measurements (Continued)

PSA-4 THICKNESS MEASUREMENTS - DATA SUMMARY - 24 OCTOBER, 1989

| Angular Location | Radial Distance Outward from the Igniter Boss |        |        |        |        |        |        |        |        |        |
|------------------|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                  | 3.5   | 4.0    | 4.5    | 5.0    | 5.5    | 6.0    | 6.5    | 7.0    | 7.5    | 8.0    |
| 250.0            | 1.0080  | 0.7275 | 0.5988 | 0.5716 | 0.5706 | 0.5739 | 0.5757 | 0.5845 | 0.5840 | 0.5868 |
| 255.0            | 0.9836  | 0.7105 | 0.5689 | 0.5608 | 0.5730 | 0.5761 | 0.5850 | 0.5856 | 0.5841 | 0.5868 |
| 260.0            | 0.9971  | 0.7154 | 0.5939 | 0.5658 | 0.5650 | 0.5710 | 0.5709 | 0.5798 | 0.5847 | 0.5903 |
| 265.0            | 1.0344  | 0.7103 | 0.5987 | 0.5663 | 0.5680 | 0.5720 | 0.5742 | 0.5816 | 0.5844 | 0.5830 |
| 270.0            | 1.0074  | 0.6999 | 0.5907 | 0.5700 | 0.5643 | 0.5683 | 0.5714 | 0.5811 | 0.5818 | 0.5832 |
| 275.0            | 0.9847  | 0.7049 | 0.5908 | 0.5600 | 0.5652 | 0.5688 | 0.5706 | 0.5828 | 0.5821 | 0.5844 |
| 280.0            | 0.9298  | 0.6707 | 0.5804 | 0.5603 | 0.5620 | 0.5674 | 0.5705 | 0.5816 | 0.5824 | 0.5830 |
| 285.0            | 0.9657  | 0.6636 | 0.5765 | 0.5605 | 0.5626 | 0.5676 | 0.5782 | 0.5820 | 0.5811 | 0.5841 |
| 290.0            | 0.9597  | 0.6925 | 0.5872 | 0.5584 | 0.5584 | 0.5647 | 0.5764 | 0.5855 | 0.5850 | 0.5884 |
| 295.0            | 0.9458  | 0.7012 | 0.5849 | 0.5543 | 0.5540 | 0.5612 | 0.5722 | 0.5782 | 0.5834 | 0.5878 |
| 300.0            | 0.9847  | 0.6937 | 0.5876 | 0.5570 | 0.5489 | 0.5731 | 0.5622 | 0.5736 | 0.5722 | 0.5721 |
| 305.0            | 0.9620  | 0.6675 | 0.5712 | 0.5454 | 0.5505 | 0.5577 | 0.5624 | 0.5718 | 0.5697 | 0.5695 |
| 310.0            | 0.9772  | 0.6998 | 0.5871 | 0.5588 | 0.5537 | 0.5590 | 0.5624 | 0.5683 | 0.5656 | 0.5568 |
| 315.0            | 0.9680  | 0.7012 | 0.5969 | 0.5599 | 0.5590 | 0.5624 | 0.5740 | 0.5812 | 0.5824 | 0.5843 |
| 320.0            | 0.9739  | 0.6795 | 0.5796 | 0.5606 | 0.5576 | 0.5622 | 0.5765 | 0.5800 | 0.5819 | 0.5848 |
| 325.0            | 0.9431  | 0.6802 | 0.5873 | 0.5597 | 0.5596 | 0.5675 | 0.5751 | 0.5808 | 0.5803 | 0.5834 |
| 330.0            | 1.0202  | 0.7372 | 0.6064 | 0.5747 | 0.5646 | 0.5726 | 0.5759 | 0.5840 | 0.5865 | 0.5900 |
| 335.0            | 0.9825  | 0.7173 | 0.5920 | 0.5680 | 0.5681 | 0.5750 | 0.5799 | 0.5872 | 0.5904 | 0.5943 |
| 340.0            | 0.9611  | 0.6991 | 0.5884 | 0.5649 | 0.5669 | 0.5803 | 0.5831 | 0.5895 | 0.5895 | 0.5899 |
| 345.0            | 0.9047  | 0.6554 | 0.5795 | 0.5673 | 0.5712 | 0.5784 | 0.5805 | 0.5843 | 0.5844 | 0.5863 |
| 350.0            | 1.0372  | 0.7557 | 0.6022 | 0.5770 | 0.5764 | 0.5827 | 0.5835 | 0.5824 | 0.5863 | 0.5901 |
| 355.0            | 1.0404  | 0.7674 | 0.6171 | 0.5759 | 0.5692 | 0.5745 | 0.5801 | 0.5898 | 0.5916 | 0.5917 |
| 360.0            | 1.0907  | 0.8056 | 0.6421 | 0.5849 | 0.5729 | 0.5819 | 0.5860 | 0.5850 | 0.5849 | 0.5873 |
| Average          | 1.035   | 0.737  | 0.604  | 0.567  | 0.564  | 0.568  | 0.573  | 0.579  | 0.580  | 0.581  |
| S.O.             | 0.065   | 0.044  | 0.025  | 0.012  | 0.009  | 0.009  | 0.008  | 0.009  | 0.010  | 0.011  |
| Maximum          | 1.201   | 0.853  | 0.673  | 0.597  | 0.589  | 0.583  | 0.588  | 0.592  | 0.595  | 0.591  |
| Minimum          | 0.905   | 0.655  | 0.560  | 0.539  | 0.539  | 0.545  | 0.546  | 0.546  | 0.545  | 0.544  |